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UNITED STATES DEPARTMENT OF AGRICULTURE

Collecting Wild Potatoes in Mexico[1]

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THIS circular is a more complete report than the one previously published[3] of a potato-collecting expedition in 1947-48 to the highlands of south-central Mexico. It is concerned almost entirely with the writer's field work in Mexico and includes his observations of the occurrence and distribution of tuberous solanums found in that country. A report on the identification and taxonomy of the collections made is deferred for a later publication.

Unlike most previous expeditions sent out by the Department of Agriculture, this one was directed primarily toward obtaining tubers, fruits, and botanical specimens of potatoes only, instead of economic plants in general. Consequently, although field work in Mexico did not begin until late in 1947, a rather large collection of potatoes was assembled in the course of 3 months. The purpose of the expedition was to obtain living material of as many different species of indigenous potatoes or of as many strains within a given species as possible. Since some wild Mexican potatoes are known to be resistant to certain potato diseases (especially to attacks of *Phytophthora infestans* (Mont.) De Bary), the collections made are to be used in breeding work with our domestic varieties to try to obtain more vigorous strains with greater resistance to disease, drought, and frost and adaptability to various climatic regions.

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[1] Report of a study made under the Research and Marketing Act of 1946.

[2] Appreciation is expressed to the Dirección General de Agricultura de Mexico and the Rockefeller Foundation, working in close collaboration with the Dirección General de Agricultura, for the many courtesies extended: to Dr. J. G. Harrar, Field Director for Agriculture in Mexico, The Rockefeller Foundation, and members of his staff for helpful advice and friendly cooperation: to Señor Isidro Cisneros, for his invaluable assistance throughout the trip: to staff members of various American herbariums, for assistance in this project: and to representatives of the United States Department of State in Mexico, for their close cooperation, which materially facilitated the work. For figures 1, 5, 6, 7, 8, 15, 21, 24, credit is given to commercial photographers in Mexico who issued the original photographs as scenic postcards.

[3] Correll, D. S. wild potato collecting in mexico. Field and Lab. 16: 94–112, illus. 1948.

POTATO EXPEDITIONS TO MEXICO

Only during the past 25 years have scientists, other than systematists, become seriously interested in the potato in its native region. This interest extends not only to the wild species but also to the cultivated ones and to the variations found within both. In 1925 and during several subsequent years Russian expeditions were made into Middle and South America primarily for collecting material of cultivated potatoes. As a result of these expeditions, especially in South America, about 18 new cultivated and 30 new wild species of potato were described, largely from living material. Realizing the practical importance of these related species to any potato-breeding program, scientific organizations in other countries, including Sweden, Germany, England, and the United States, have sent out similar expeditions to one or both of these regions.

The Russians, who were primarily interested in the cultivated potatoes of Middle and South America, did most of their collecting in the latter region. In 1925-26, however, one member of the expedition, M. S. Antipovicz, made some collections of wild potatoes in the Distrito Federal and in the States of México and Tabasco. Writing of this expedition, in 1930, Bukasov [4] stated that in spite of special attention paid to the matter, only very restricted material of wild potatoes could be collected as they proved to be of rare occurrence, and that careful survey and continued collecting in a small region were found more productive. Later, however, although the Russians admittedly scarcely touched the vast wild potato region of Mexico, Bukasov [5] considered their field work to be so complete that he implied that further exploration would add little to what they had done.

The expedition by the United States Department of Agriculture, which was in Mexico from late August to late December 1930, made 67 collections, including in most instances both tubers and seeds. All these collections were considered to be wild species and were found in the Distrito Federal (36 collections) and the following States: Puebla, 16; Morelos, 8; México, 4; Hidalgo, 2; Querétaro, 1. These specimens were utilized in breeding with our domestic stock. Since no systematic work was undertaken with the complete collection, no new species or varieties were described.

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[4] BUKASOV, S. M. THE CULTIVATED PLANTS OF MEXICO, GUATEMALA AND COLOMBIA. Trudy Prikl. Bot., Genet., i Selek. (Bul. Appl. Bot., Genet., and Plant Breeding), Sup. 47: 191–226, 513–523, illus. [In Russian, with English summary.] 1930.

[5] BUKASOV, S. THE POTATOES OF SOUTH AMERICA AND THEIR BREEDING POSSIBILITIES. Lenin Acad. Agr. Sci., U. S. S. R. Inst. Plant Indus. (Sup. 58 to Bul. Appl. Bot., Genet., and Plant Breeding), 192 pp., illus. Leningrad. [In Russian, with English summary.] 1933.

In 1938-39 the British Empire Potato Collecting Expedition was sent into Mexico and South America. Profiting by the experience of previous expeditions, the members sent back to England a large and valuable collection, from which 5 new cultivated and 30 new wild species were described.

According to Hawkes,[6] the Mexican excursion of the British Expedition was undertaken from April 1 to October 31, 1938. Thirty-eight collections of wild potatoes were obtained: In the Distrito Federal, 5; in the States of México, 14; Tlaxcala, 9: Veracruz, 9; and Puebla, 1. Most of the potatoes were taken from the high slopes of La Malinche (Tlaxcala), Nevada de Toluca (México), Pico de Orizaba (Veracruz and Puebla), Popocatepetl (México) (fig. 1), and Cofre de Perote (Veracruz). From the above collections 3 new species, 4 new varieties, and 4 new forms were described.

During the writer's 3 months' work in Mexico in 1947–48, trips were made into 14 States and collections of indigenous potatoes were obtained from 12. Travel was by automobile, bus, train, and mule and to a large extent on foot. Besides the 110 collections of wild or semiwild potatoes, which consisted of from a few potatoes in some collections to as many as 6 liters or more in others, a number of cultivated specimens were taken either directly from fields or were bought in various markets throughout the country. The number of collections of indigenous potatoes from each State is as follows (fig. 2) : México, 24; Michoacán, 22; Hidalgo, 8; Puebla, 8; Tlaxcala, 5; Jalisco, 4; Veracruz, 4; Guerrero, 2: Morelos, 2; Oaxaca, 2; and Querétaro, 1; and from the Distrito Federal, 27. Although Colima and Guanajuato were visited, no indigenous potatoes were found in either.

Except for possible unknown miscellaneous collections, the writer is aware of no living material previously taken from Guerrero, Jalisco, and Michoacán. In view of this, it is most likely that some of the collections from these States, a number of which are from the summit or high slopes of isolated mountain ranges, will be of much interest to the breeder as well as to the systematist when taxonomic work on the material is completed.

With the publication, in 1944, of Hawkes's comprehensive study and report of the results of the British Expedition, about 25 cultivated and 150 wild species of potatoes had been described. It is impossible at this time to forecast the possibilities of any additions to this number in the material the writer obtained in Mexico. Doubtless, however, there are still large numbers of additional wild and semiwild species to be found in Middle and South America, especially in isolated and practically inaccessible regions yet to be explored.

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[6] HAWKES, J. G. POTATO COLLECTING EXPEDITIONS IN MEXICO AND SOUTH AMERICA. Imp. Bur. Plant Breeding and Genet., 30 pp., illus. Cambridge. 1941.

———POTATO COLLECTING EXPEDITIONS IN MEXICO AND SOUTH AMERICA. II. SYSTEMATIC CLASSIFICATION OF THE COLLECTIONS. Imp. Bur. Plant Breeding and Genet., 142 pp., illus. Cambridge. 1944.

Figure 1.—Popocatepetl, as seen from Amecameca, México. Its forested slopes contain many wild potatoes.

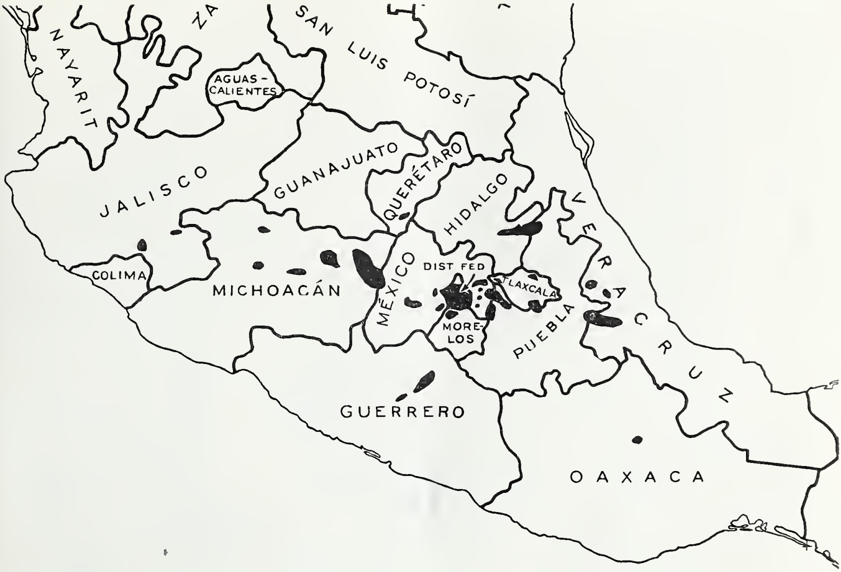

FIGURE 2.—South-central Mexico: The black areas mark regions in which explorations were made by the 1947-48 expedition and from which potatoes were collected.

THE AMERICAN POTATO EXPEDITION OF 1947-48

Departmental plans were developed in 1947 for sending the expedition to Mexico, and the writer was assigned the duty of carrying out the field exploration. Several species, namely *Solanum demissum*,[7] *S. sambucinum*, and *S. polyadenium* (figs. 3 and 4), were especially desired.

In order to determine definite localities where the above and other species grow, data were obtained from herbarium specimens of all the known Mexican species in the section Tuberarium of the genus *Solanum* deposited in the larger herbariums in the United States. A study and evaluation of these records aided in planning the itinerary in advance.

The herbarium specimens revealed that the largest number of species and the greatest concentration of potatoes occurred in the States of México, Michoacán, Hidalgo, Oaxaca, Puebla, and Veracruz and in the Distrito Federal. Fifteen species were known to occur in México, 13 in the Distrito Federal, 12 in Michoacán, 10 in Veracruz, 8 in Hidalgo, and 7 each in Oaxaca and Puebla. Furthermore, in these 7 States 28 of the 40 species occurring in Mexico were to be found.

Of the 3 species most desired, *S. demissum* occurred most frequently, being found in 10 States; whereas *S. polyadenium* occurred only in Hidalgo, México, and Michoacán, and *S. sambucinum* was apparently confined to Querétaro.

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[7] Authorities for the scientific names are given at the end of the circular, in the section listing the species and the States in which they occur.

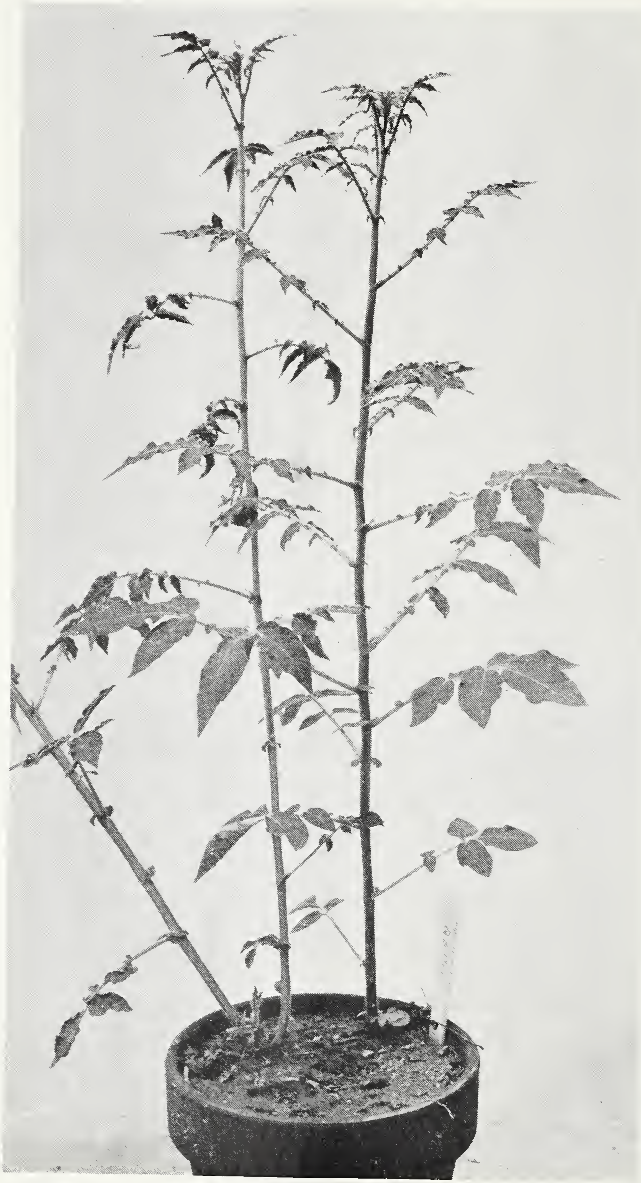

FIGURE 3.—Plants of *Solanum polyadenium* grown in quarantine. P. I. 161710[8] and P. I. 161728. About × 1/5.

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[8] P. I.=accession numbers of the Division of Plant Exploration and Introduction.

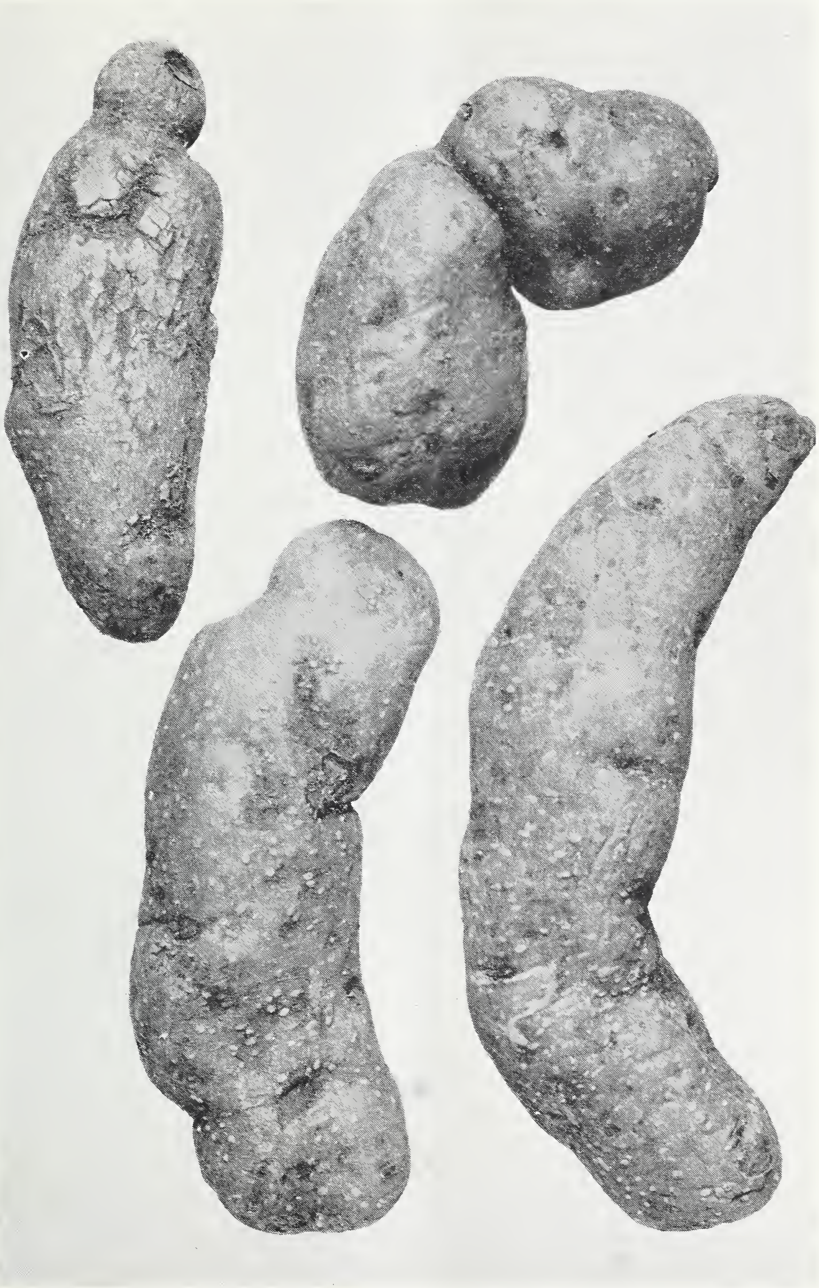

FIGURE 4.—Tubers of *Solanum polyadenium* collected among rocks in an old lava flow near Matujeo, Michoacán. P. I. 161710. About × 1.

The information gained from these herbarium records later proved of inestimable value in the field and greatly facilitated the rapid assembling of a number of collections before the plants were killed by cold or drought and thus obliterated.

Supplied with the above information, the expedition left Washington on October 15 and arrived in Mexico City on October 19, 1947. It returned to Washington on January 15, 1948.

Upon the advice of several agriculturists and others who were somewhat familiar with the regions in Mexico that were considered best to explore, the writer obtained an automobile for travel and was also fortunate in employing at the same time a competent Mexican assistant, who accompanied him throughout the trip. The availability of a car was of special help, particularly when large and heavy collections were made and where public transportation was irregular or lacking. It was thus possible to reach quickly and explore regions that otherwise would have been almost, if not entirely, inaccessible.

In order to obtain material from as many places as possible and thus offer the plant breeder more species or more strains within a species with which to work, the expedition moved rapidly at first instead of spending too much time in any one region. Also, the first few weeks were devoted to investigating some of the definite localities known. This proved to be most fruitful, since the writer arrived in Mexico so late in the season that potato plants in many of the localities first visited were already turning brown. Fortunately, the unusually late rains in the central highlands of Mexico during October, November, and early December prevented the early drying up of plants and thus prolonged the growing season considerably beyond the average.

After the known localities for potatoes were investigated, work was undertaken in more or less unexplored territory. During this period time-consuming mule trips were taken to some of the almost inaccessible mountain ranges. In several cases potatoes were obtained from rather disjunct and isolated areas in Jalisco, Guerrero, Michoacán, and Oaxaca beyond the more concentrated range of the indigenous potatoes. On the basis of the observations and findings in these isolated areas, it is believed that a number of additional similar mountain ranges seen in the above States and México could be profitably explored by pack train.

The regions of most intensive potato exploration in the past have been on the slopes of some of the great volcanic peaks, namely Pico de Orizaba, Sierra Negra, Cofre de Perote, Ajusco, Popocatepetl, Nevada de Toluca, and La Malinche. Besides the explorations on the upper slopes of these mountains, work was undertaken on the upper slopes of Ixtaccihuatl (fig. 5) and Volcán de Nevada (fig. 6), as well as on several lesser and somewhat isolated mountain ranges. The areas of greatest exploration, doubtless because of their proximity and accessibility to Mexico City, are not only in the Distrito Federal itself but also in parts of México, Puebla, and Veracruz. In these 4 States and in Tlaxcala is concentrated one of the largest areas of mesophytic mountain forests in the country. Also, as noted before, these 4 States lie within the region where 28 of the 40 tuberous solanums occur in Mexico.

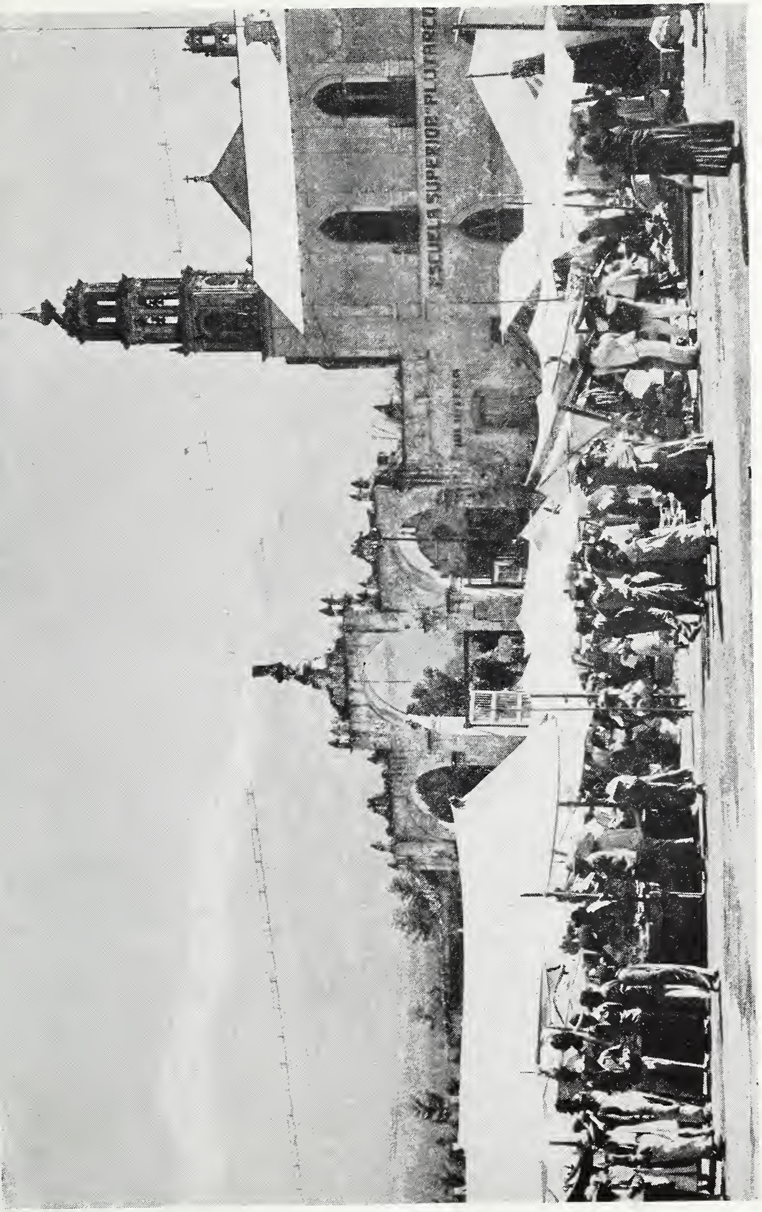

FIGURE 5.—Ixtaccihuatl, as seen from a typical market at Amecameca, México. Various types of cultivated potatoes may be found in the local markets.

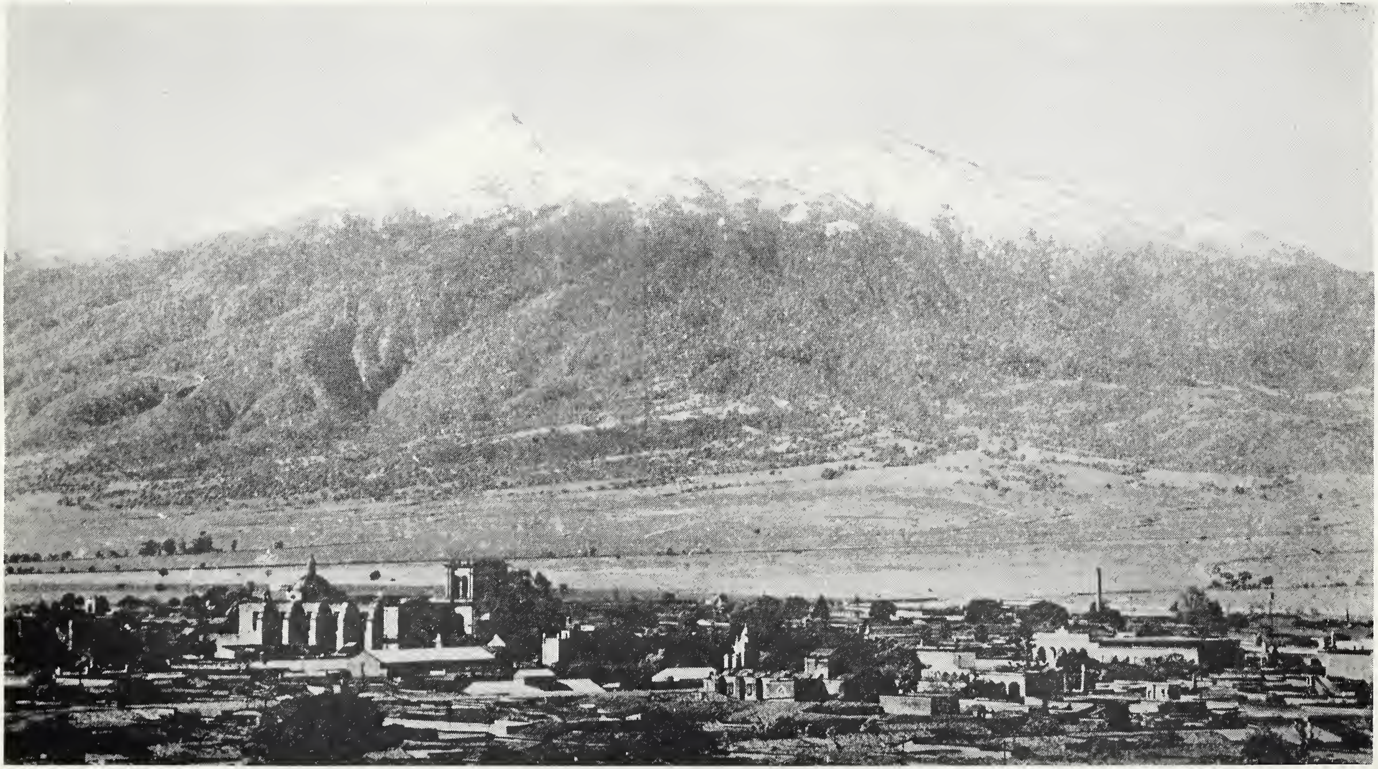

Figure 6.—View of Volcán de Nevada, as seen from Ciudad Guzmán, Jalisco. Several collections of potatoes were taken from its upper slopes.

POTATO HABITATS

With few exceptions, all the potatoes collected grew in the pine or pine-balsam zone above 8,000 feet altitude (fig. 7). The majority of the collections grew around 9,000 feet. One collection *(Solanum suaveolens)*, however, was obtained near Teocelo, Veracruz, at about 4,000 feet, and a few were made around 12,000 feet. In the writer's opinion, few if any species are to be found in Mexico above the latter elevation, but the bulk of the choice indigenous potatoes of Mexico may be said to grow at an elevation between 8,000 and 11,000 feet. This zone lies mostly within the coniferous forest region and the area in which a large part of the commercially grown potatoes are to be found in south-central Mexico.

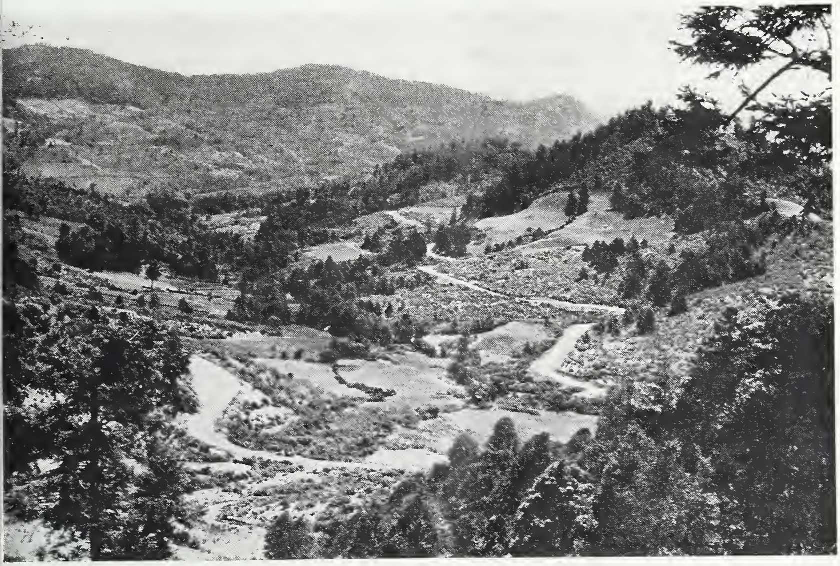

Figure 7.—Near Mil Cumbres, along the highway between Zitacuaro and Morelia, Michoacán, a region of many indigenous potatoes.

In all cases where pine-balsam forests or pure stands of balsam occurred (fig. 8), one or more species of potatoes were to be found. In fact, some of the largest and best collections were growing about the base of balsam or pine trees, usually in deep litter. Many species are not only tolerant of acidulous ground litter but definitely thrive in such habitats.

There appeared to be no distinctive habitat for potatoes, as far as sun and shade were concerned. Collections were made under all conditions of exposure and shelter. Plants were most frequently found, however, in thickets, about maguey plants, or growing in brush piles, doubtless because they were there protected from grazing animals. Plants that grew at the lowest elevations and were sheltered were usually more spindly and their internodes more elongate than those in similar habitats at higher elevations. This, however, may be because they were dissimilar species or different strains of the same

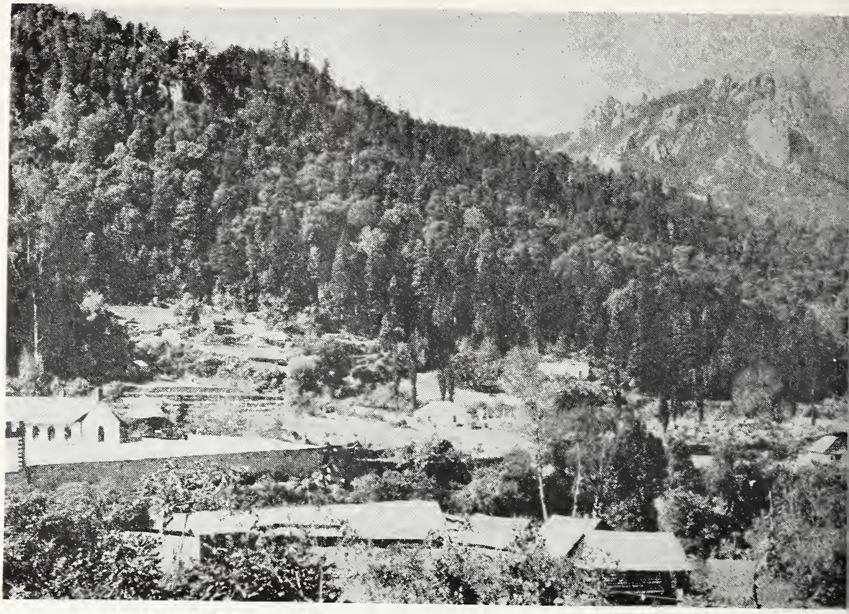

Figure 8.—Balsam forest in the vicinity of Real del Monte, Hidalgo, the type locality of *Solanum verrucosum*.

species rather than because of altitudinal differences. The future identification of the collections made should clarify this point.

Many tuberous solanums exhibit the characteristics and propensities of weeds in that they are often early invaders of disturbed soils, newly exposed areas, and cultivated fields. Farmers in the potato regions consider wild and semiwild potatoes among the most noxious weeds with which they have to cope. Potatoes appear to hold their own against competition until destroyed or crowded out by other, often woody, plants. Some collections were obtained from such places as old camp sites, areas where brush had been burned or cattle and horses bedded down, and in newly cut-over and cleared land.

The 5 habitats and numbers of collections from each are as follows: In or on the very edge of coniferous or mixed coniferous-hardwood forests, 35; in thickets or among shrubs, commonly on the edge of forests, 29; on the edge of corn, cereal, potato, or other cultivated fields, often among maguey plants, about trees, or in open thickets, 20; among corn, cereal, potato, and other crop plants, 20; in pastures, grasslands, and on open banks or ledges, 6. Nearly all of these 110 collections were obtained in the coniferous forest zone at various altitudes.

DISEASES AND ENEMIES

In the field most of the plants observed or collected as well as the tubers and fruits collected appeared to be disease- or pest-free. Some plants, however, were apparently attacked by fungi or a virus, and larvae were found in some fruits and tubers. Miners, weevils, and scab were noted in a few tubers.

Upon arrival at the Department of Agriculture inspection house in Washington, inspectors found dipterous larvae and pupae and scavenger beetles in fruits of some of the collections. Infestations noted in some of the tubers were *Rhizoctonia solani* Kuehn; a powdery scab (caused by *Spongospora subterranea* (Wallr.) T. Johns.); common scab (by *Actinomyces scabies* (Thaxt.) Guess.); tuber miners; weevil larvae (*Epicaerus cognatus* Sharp); dry rot; hard rot; storage rot; lepidopterous larvae; and silver scurf (caused by *Spondylocladium atrovirens* Harz). The true seeds, which are considered to be free from and nontransmitters of disease, were extracted from the pulp and sent to several geneticists for their research. The tubers were immersed in a solution of mercuric chloride ($HgCl_2$, 1 : 1000) for 90 minutes, and are being propagated in quarantine (fig. 9) before the material is released for experimental work. Despite the seemingly large number of parasites found in the collec-

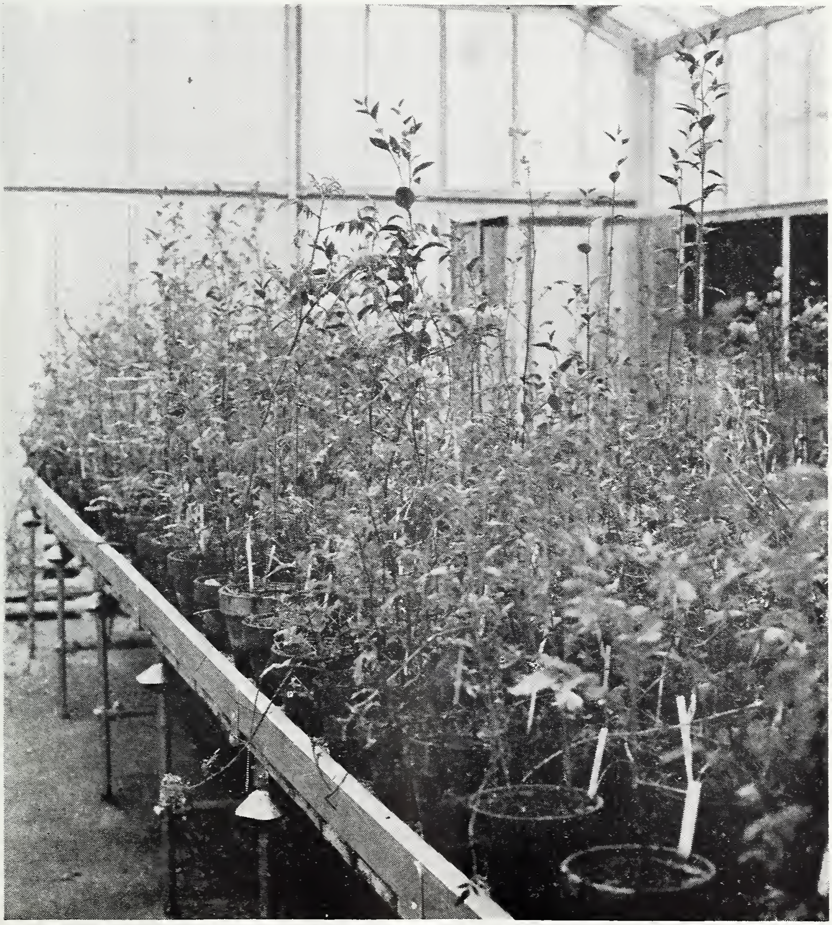

FIGURE 9.—Mexican potatoes grown in quarantine at the United States Plant Introduction Garden, Glenn Dale, Md.

tions, a number were entirely free from infestations of any sort. It is especially from this latter material that the desired genetical factors may be derived.

Potato plants are a favorite food of goats, sheep, cattle, and wild grazing animals. The fruits also are eaten by birds and rodents, and the tubers are devoured by hogs and burrowing animals. Because of their many enemies, plants are seldom found in unprotected habitats except in extremely isolated regions; they survive only in brush, along fences, or within other barriers erected against animals. They occur especially about the bases of maguey plants, whose rigid spiny leaves afford ample protection from grazing animals. In the potato zone, wherever the land is planted to corn, beans, potatoes, cereals, or other crops, wild and semiwild potatoes may be found, since these places are usually given some protection against grazing animals.

UTILIZATION OF POTATOES

It is not known to what extent the tubers of wild or semiwild species are utilized for food in Mexico. In many localities visited, however, especially in Jalisco, Michoacán, Veracruz, and Oaxaca, the writer was told that at various times during the year Indians brought to village markets wild tubers that they had dug in the mountains. Charcoal and wood haulers who brought their burro loads to market from timbered mountain slopes usually seemed to be more familiar with wild potatoes than most natives. They stated that they frequently used them in soups and stews. The writer has tasted many Mexican potatoes, both raw and cooked, and has found them to vary greatly in texture and flavor. From the crisp, astringently bitter tubers of *Solanum bulbocastanum* (figs. 10 and 11) to the tender, mildly sweet tubers of some strains of *S. demissum* and *S. longipedicellatum*, one may find all degrees of texture and flavor.

Tubers of potatoes cultivated in Mexico are exceedingly variable in size, shape, color, texture, and flavor. Although the common potato of cultivation in the United States and throughout most of the world is *S. tuberosum* or variants of that species, such is apparently not the case in Middle and South America, where Bukasov and Hawkes found a number of species in cultivation. The writer obtained tubers from cultivation that unquestionably represent several different species. For instance, in the native market of Ciudad Guzmán, Jalisco, one vendor was selling potatoes grown in the vicinity of Atoyac, Jalisco, that included seven distinct types.

The age-old practice of bringing into cultivation either accidentally or purposely wild (or natural hybrids of wild and cultivated) species of potatoes has resulted in the necessity of giving consideration to what are wild and what are cultivated species in the region where they are indigenous. For practical purposes, the wild species already described, as well as those that were found in a wild state and were considered not to be escapes from cultivation, are here considered as wild.

The most widely used vernacular name for indigenous potatoes in Mexico is "papa cimarrona," meaning simply "wild potato." In some regions, however, they are called "papa coyote" (native potato), "papa silvestre" (wild potato), or "papa del monte" (mountain potato).

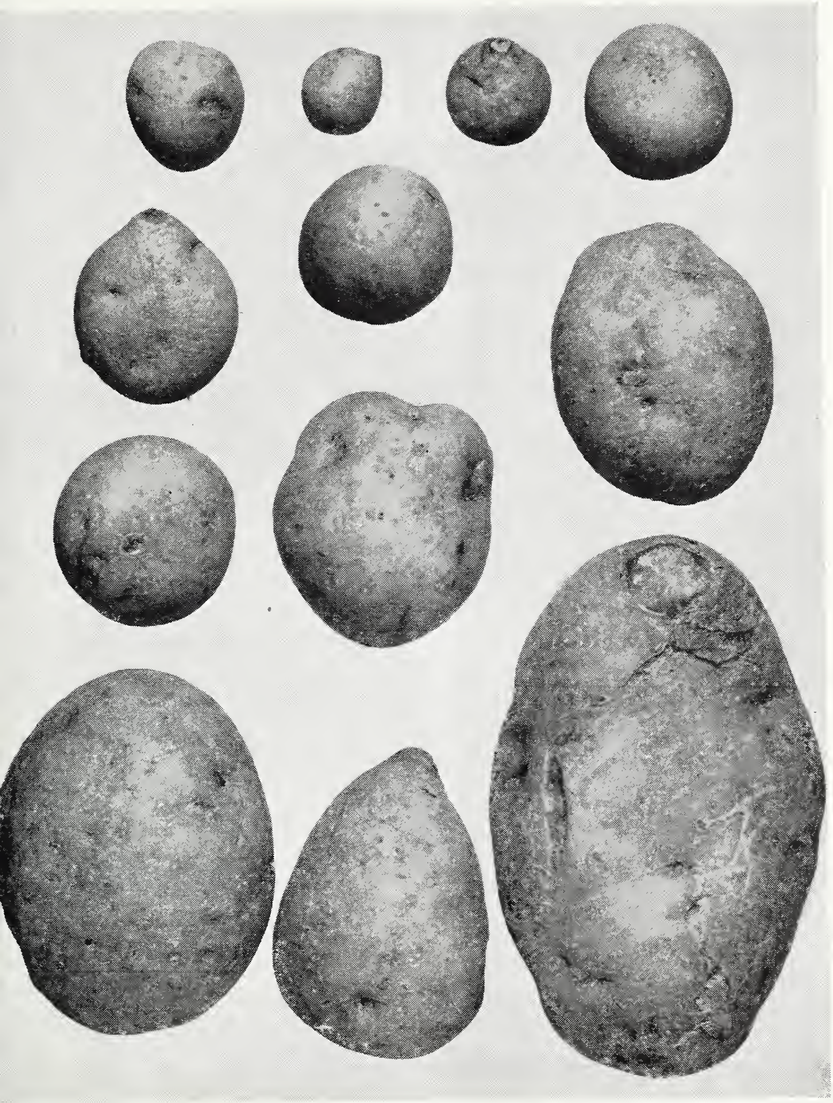

FIGURE 10.—Tubers of *Solanum bulbocastanum* collected on Mount Punguato, near Morelia, Michoacán. P. I. 161712. About × 1.

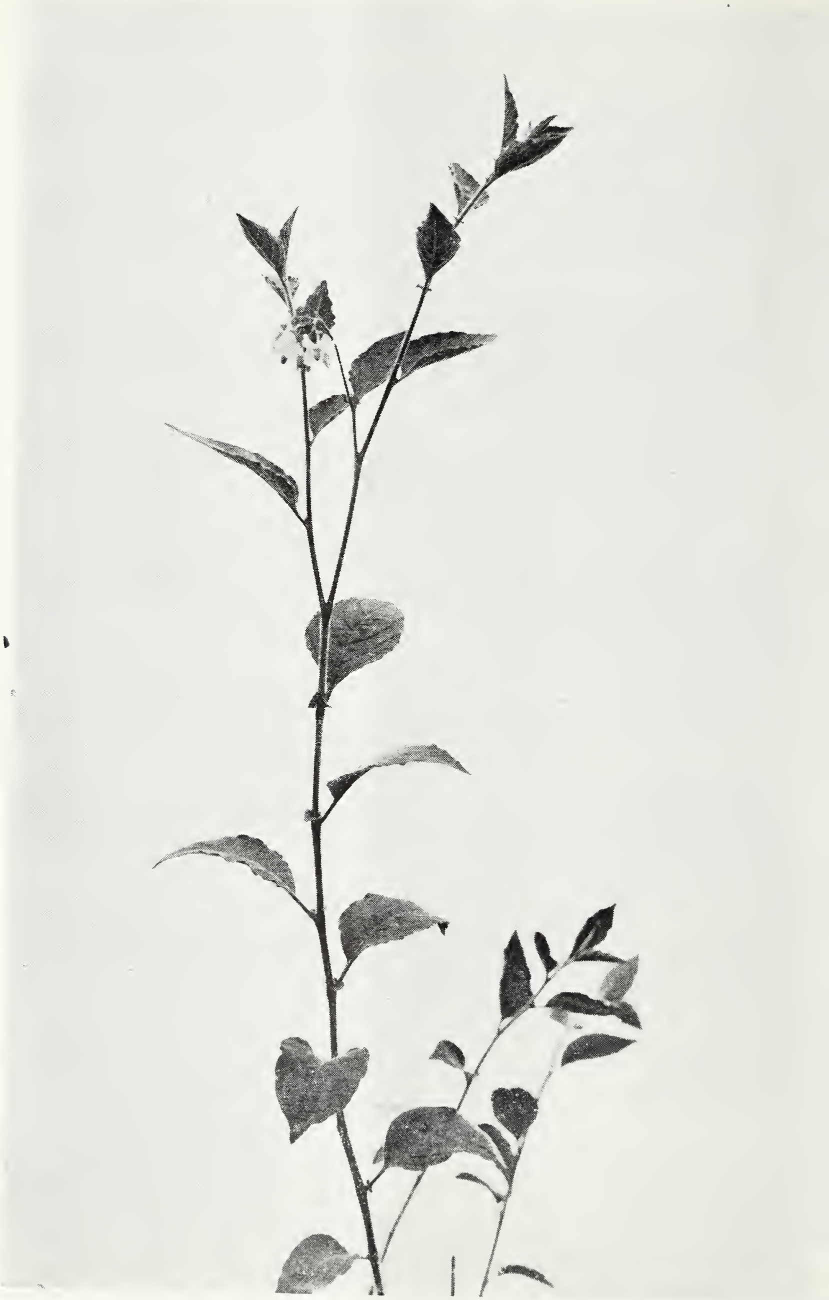

FIGURE 11.—Upper part of plant of *Solanum bulbocastanum*, grown in quarantine. P. I. 161712. About × ¼.

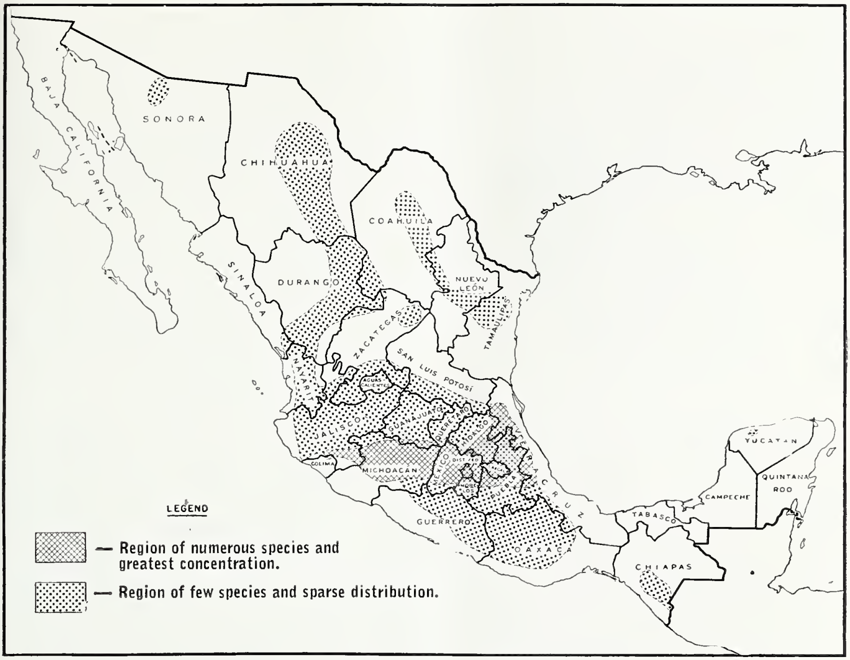

Figure 12.—Distribution of wild potatoes in Mexico.

GENERAL DISTRIBUTION OF WILD POTATOES IN MEXICO

For the most part, tuberous solanums occurring in Mexico have been obtained by collectors for breeding work and not so much for the purpose of showing the distribution of the various species. Hence, collecting has been concentrated in central Mexico, radiating from Mexico City, because large collections are rather easily obtainable in this region. Nevertheless, sufficient incidental botanical collections exist to reveal the general trend and pattern of distribution of the species as a whole—not as individual species.

As shown by figure 12, tuberous solanums occur for the most part either in mountain ranges or on high plateaus. The region of greatest numbers of species, variations within species, and greatest concentration of potatoes extends in a rather broad belt from the escarpment of Veracruz west to Volcán Colima, Jalisco, where the belt is perceptibly narrower than in the east. Directly north and south, adjacent to this region, are broad belts of lower and more or less xerophytic country, where potatoes are principally limited to isolated mountain summits. The southern belt has its southwestern boundary on the upper slopes of Sierra Madre del Sur, Guerrero, while the northern belt has its northeastern boundary on the tapering slopes of the broad central plateau.

North of the second belt are two zones running north and south, of which the eastern closely conforms to the Sierra Madre Oriental, while the western lies on the eastern slopes of Sierra Madre Occidental, and partly on the plateau extending northward between these two ranges. To the north and south of the central potato region are isolated areas. In Sonora, *Solanum fendleri*, *S. jamesii*, and *S. tuberosum*, all of which occur northward into the United States, have been collected in the vicinity of Altar. The isolated station in Yucatán represents *S. tuberosum*, doubtless an escape from cultivation; and the isolated region in Chiapas lies in the Sierra Madre.

There is little doubt that, from records of the wild and semiwild potatoes of Mexico, the known distribution conforms more to the convenience and accessibility of the country to collectors than to actual occurrence. This is usually true of most plant distribution data. Nevertheless, it is believed that the data given here will be useful in visualizing the distribution of tuberous solanums in Mexico.

Although many factors contribute to the distribution of potato plants, man has probably been the foremost agent in their dissemination. Through the ages the natives of Mexico have been using the potato as food. At the beginning, as in some primitive regions today, they used any palatable tuber found in nature, regardless of its size. Tubers were probably transported when migrations were undertaken, and undoubtedly some were dropped or discarded along the route or were eventually transplanted and thus became established in another region. Potatoes, wild and cultivated, were also doubtless used in barter, as they are so used in trade today in some parts of Mexico.

According to Señor Tomas Fernandez Garcia, the common practice among commercial potato growers in Mexico is to exchange seed potatoes with one another from year to year. Señor Fernandez is a commercial grower whose large holdings (Rancho del Alverjon), as well as those of other growers, spread among the coniferous forests on the upper slopes of Cofre de Perote, Veracruz. The potatoes he was harvesting in the winter of 1947-48, for example, had their seed origin in the State of Chihuahua. The year before, he had obtained seed potatoes from Guanajuato and in turn had sent seed potatoes to Sonora, Nayarit, and other States. In this way, a seed potato is never planted in the same soil in successive years.

The growers believe that this rotative method provides less chance for a seed potato to "run out." Actually, such a system naturally results in a general distribution of originally endemic diseases, with a consequent weakening of the crop and a decreased yield. Running out is the result of devitalization by disease. Since cultivated fields are commonly the haven of wild and semiwild species whose tubers may become mixed with those of seed potatoes, wide dissemination of indigenous species is greatly facilitated by the rotation method used among Mexican commercial growers and is a prime factor in their general distribution.

One might conclude from this that over a long period the mingling of a large number of cultivated, wild, or semiwild species or variants of these should give rise to innumerable complex hybrids. This doubtless has actually occurred. Since it is almost impossible to eliminate tubers from a field that is annually under cultivation, with the passing of decades, if not centuries, a hodge-podge eventually develops. A factor that further substantiates this is the ease with which practically all cultivated and wild species in Mexico set fruit in the region where the potato is indigenous. In this apparently optimum growing environment premature abscission of flowers and other deterrent factors do not appear to play an important part in the production or lack of production of fruits. Selfing and natural crossing is apparently achieved easily through proper pollinating agents, with consequent prolific fruiting. The fruits subsequently drop and the seeds germinate in situ. In this way manifold crosses and variants may arise.

Another factor that probably has some bearing on the problem of distribution, especially in relation to species that have escaped from cultivation or have otherwise been introduced into the native flora, is the abandonment of fields that have been planted to potatoes. It was observed in a number of localities that if a potato field is abandoned after having been poorly harvested, the potatoes reproduce themselves indefinitely and frequently form a ruderal element in the natural vegetation. Unlike the severe climate of the northern United States, where most of our commercial potatoes are grown, the comparatively mild climate of Mexico permits tubers to remain unharmed in the soil throughout the year. Old potato fields were seen in several localities that had been abandoned for so long that a turf had formed and small shrubs had become established. Yet potato plants were found in the original potato hills or rows.

GENERAL DISCUSSION

The Mexican States that offer the greatest opportunities to future exploration for species of *Solanum* are probably Michoacán, Hidalgo, Jalisco, Guerrero, and Oaxaca. In addition, Veracruz should prove extremely rich in potatoes for our breeding program if exploration could be undertaken in July, August, and September. Everywhere, especially in the six States named, the natives stated that earlier in the season many kinds of potatoes were to be found, but the time of our visit was too late to permit us to see these potatoes.

A brief discussion and summary of some of the observations, findings, and conclusions of this study of the potatoes in the more important Mexican States visited are given here. In addition, the species (excluding varieties and forms) known to occur in these States are listed.

Distrito Federal: The massive ranges to the south and west of the valley in which Mexico City lies and which form in part the boundary of the District support extensive pine-balsam forests in which are to be found large colonies of potatoes. Every expedition that has gone into Mexico in search of wild potatoes has found this particular region a paradise in which to work. It would be superfluous to mention all the localities in which potatoes have been found in the District; however, Las Cruces (figs. 13 and 14), El Desierte, La Venta, Contreras, Quatro Dinamo, El Ajusco, and El Guarda are of special interest in that they lie in a country extremely rich in potatoes. One of the expedition's largest collections was obtained near El Guarda, lying at 10,000 feet altitude south of Mexico City. There are still numerous regions that could be profitably explored, and if potatoes from Mexico are desired quickly it should be possible to obtain them easily in these mountains at all times of the year. Species occurring in the Distrito Federal are:

- *S. ajuscoënse*
- *S. andigenum*
- *S. antipoviczii*
- *S. bulbocastanum*
- *S. cardiophyllum*
- *S. demissum*
- *S. longipedicellatum*
- *S. semidemissum*
- *S. stoloniferum*
- *S. suaveolens*
- *S. tuberosum*
- *S. vallis-mexici*
- *S. verrucosum*

Hidalgo: The mountain region extending from Real del Monte (fig. 8), above Pachuca, eastward and northeastward to the Puebla border, is a region rich in potatoes. This range is rather narrow near Pachuca, but northward and eastward it becomes a wide area of high rolling tableland broken by isolated groups of peaks, and farther east it gives way to the escarpment region, where immense deep barrancas (gorges) are found. Although the writer, as well as others, has obtained potatoes from this region, it still offers great possibilities. Species occurring in Hidalgo are:

- *S. appendiculatum*
- *S. cardiophyllum*
- *S. demissum*
- *S. fendleri*
- *S. inscendens*
- *S. lanciforme*
- *S. polyadenium*
- *S. verrucosum*

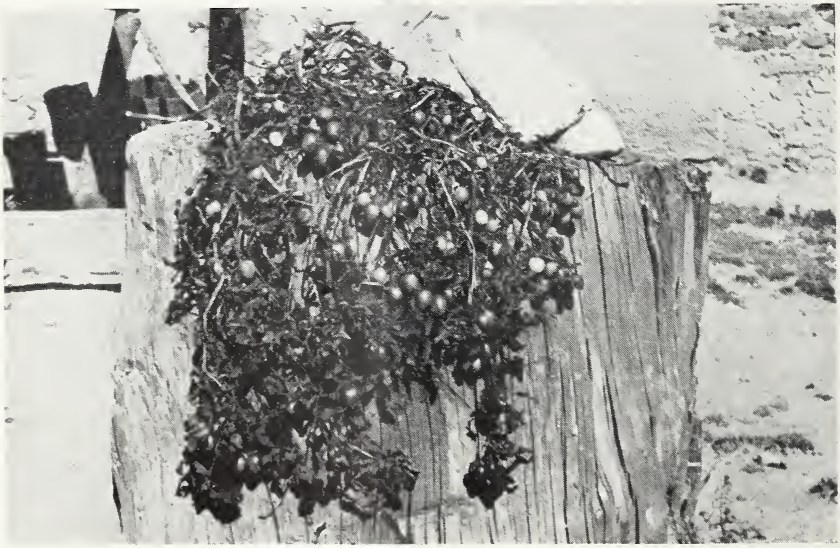

Figure 13.—Fruiting plants and bags of tubers of *Solanum demissum* collected near Las Cruces, Distrito Federal. The fruits are about 2.5 cm. in diameter. P. I. 161732 and P. I. 161747.

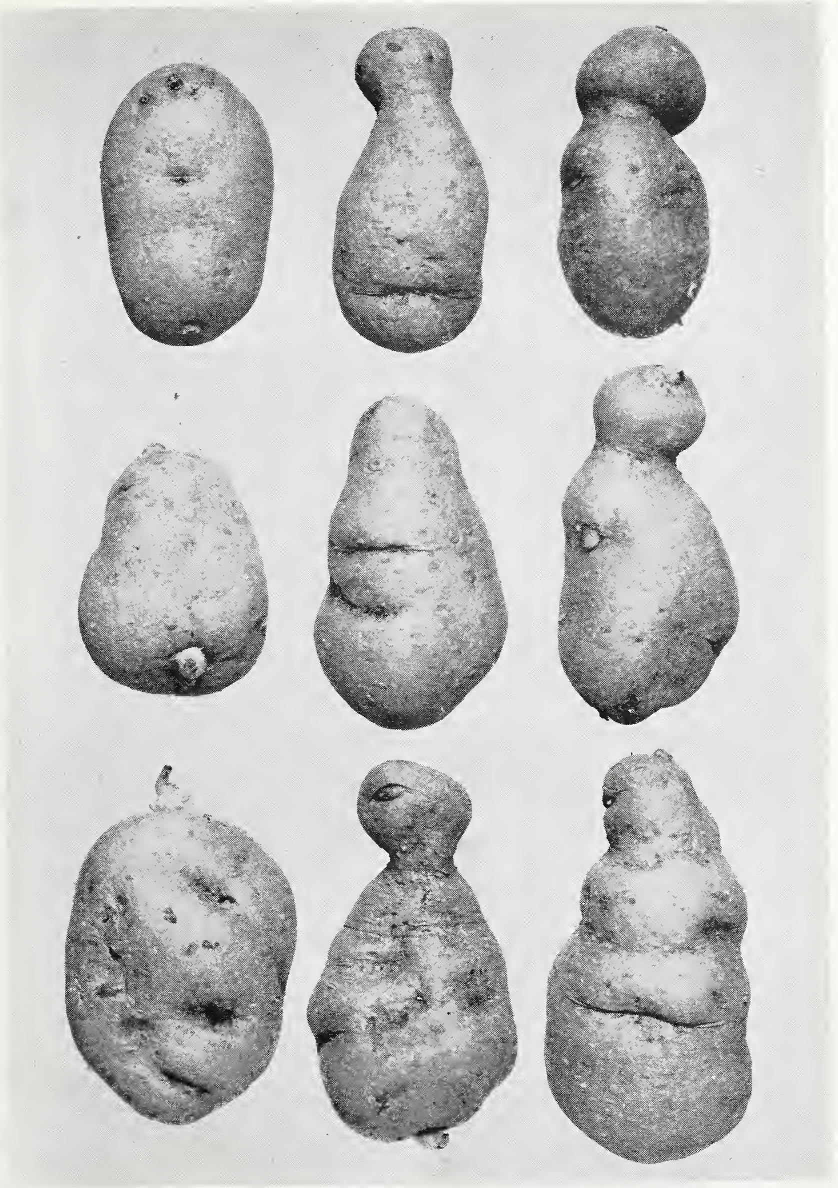

FIGURE 14.—Tubers of *Solanum demissum* collected near Las Cruces, Distrito Federal. The tubers are larger than usual. P. I. 161747. About × 1.

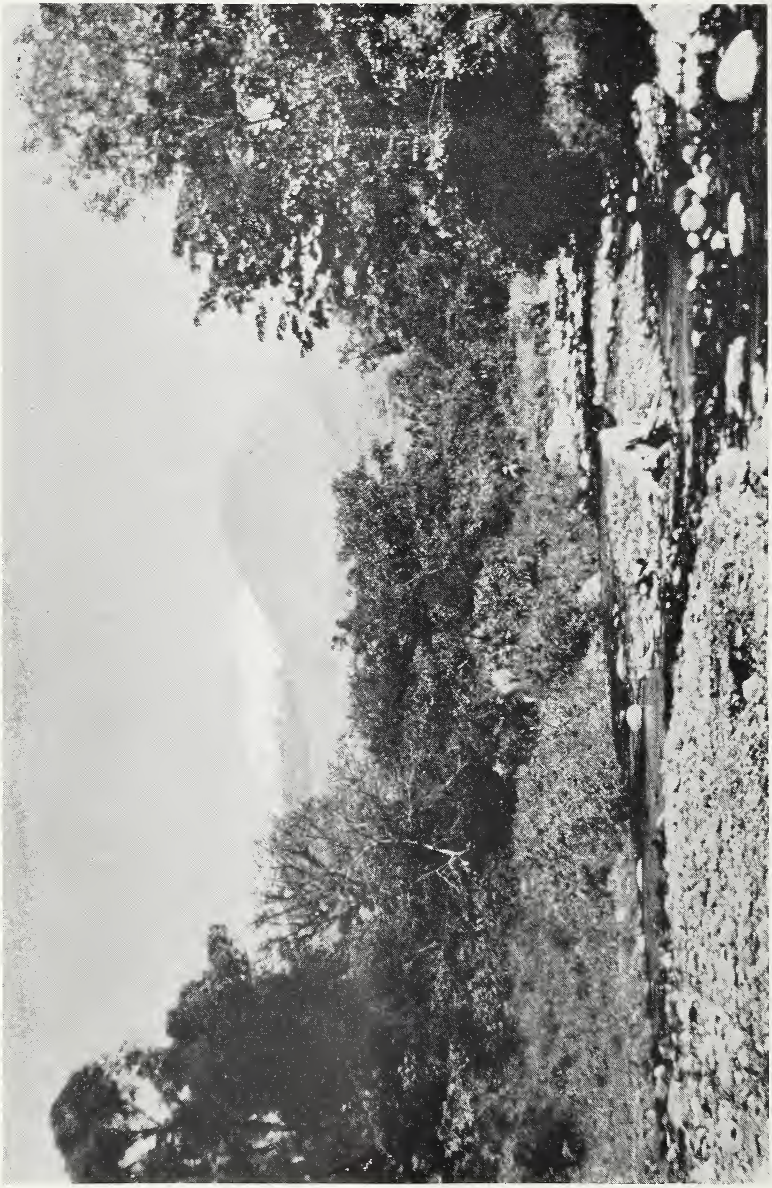

FIGURE 15.—Volcán Colima and Volcán de Nevada (snow-covered), as seen from the Colima side. These two mountains, botanically little known, should produce many varieties of potatoes.

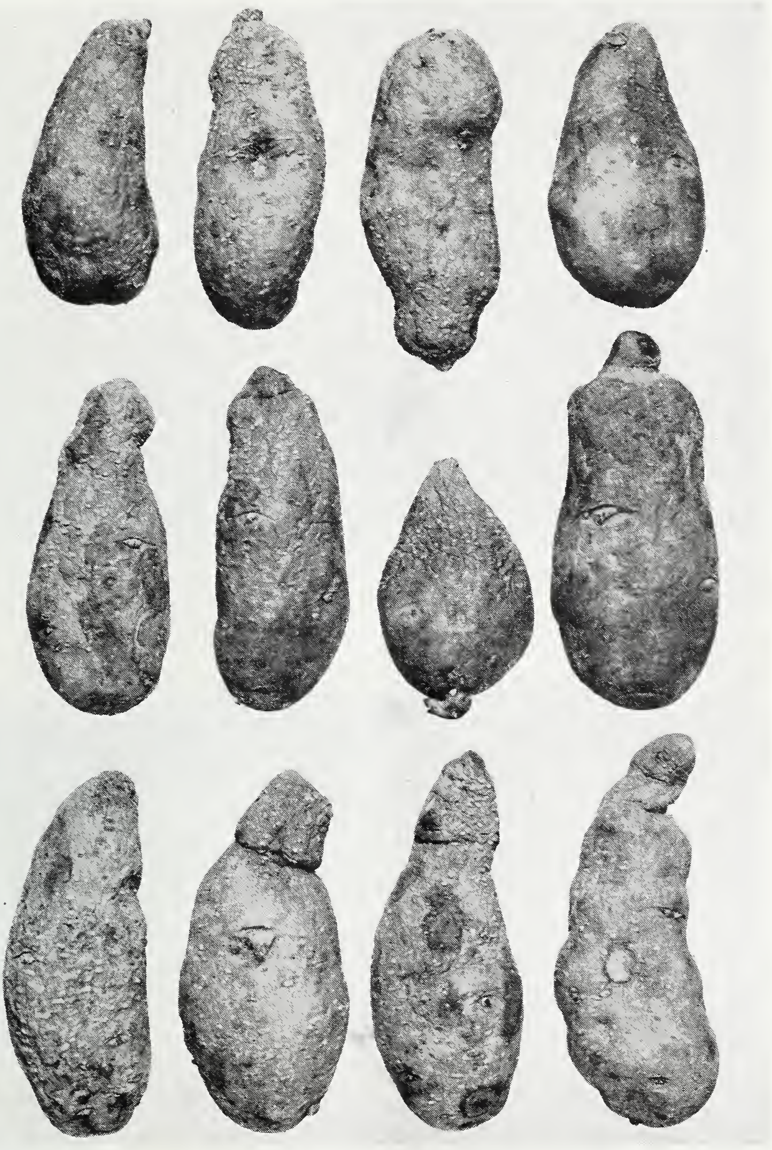

FIGURE 16.—Tubers collected in flats in snowfields near timber line on Volcán de Nevada, Jalisco. Judging from the plants grown from these tubers, this is apparently a new species. P. I. 161709. About × 1.

JALISCO: If only the mountain area comprising Volcán de Nevada (fig. 6) and Volcán Colima (fig. 15) were to be found in Jalisco, it would be well worth while as a potato region. Although only three collections were obtained from these mountains (fig. 16), there are doubtless many different potatoes to be found there. Besides the above excellent potato region there is a vast area of mesophytic mountain forests to the east and southeast of Ciudad Guzmán, which attains its greatest height in Pico de Tancitaro (Michoacán). The prominent Sierra el Tigre in this region in Jalisco would perhaps give rise to valuable potato data. Although this mountain was seen, it was not explored. The natives of Mazamitla, on the lower slopes of Sierra el Tigre, stated that many different potatoes were to be found there, especially earlier in the season. Species occurring in Jalisco are:

S. bulbocastanum
S. cardiophyllum
S. stenophyllidium
S. subvelutinum
S. verrucosum

MÉXICO: Because of its geographical situation, this State, as well as Michoacán and Puebla, offers the greatest possibilities in numbers of species and the quantity of each that may be found in Mexico. México, with its eastern border crossing the highest chain of mountains in the Nation and encompassing Nevada de Toluca, is a most productive potato region. The forest-clad slopes of Popocatepetl have provided many collections, while the slopes of Nevada de Toluca (figs. 17, 18, and 19), a large potato-growing region, support a number of indigenous species. Exploration was carried on from the base of Popocatepetl, beginning just above Amecameca (fig. 1), up to the

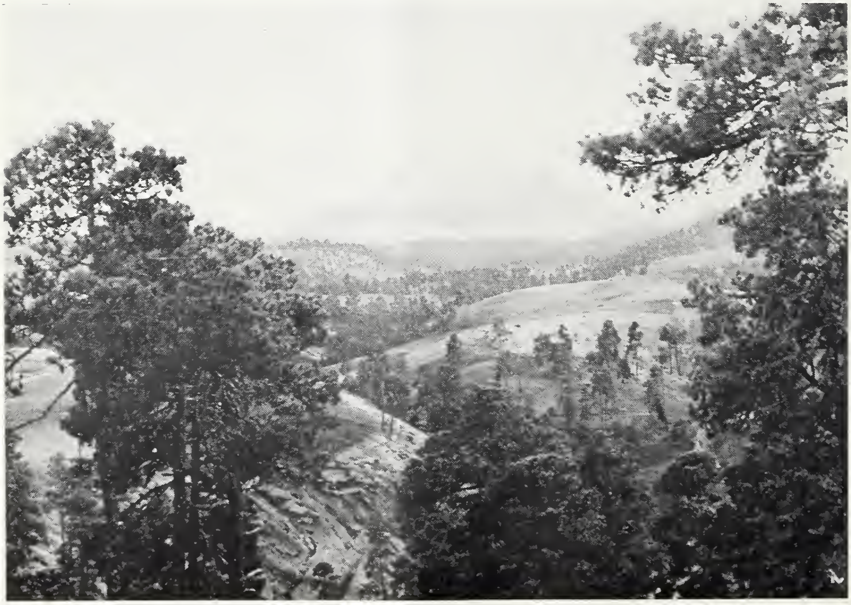

FIGURE 17.—Nevada de Toluca, México, a mountain famous for its potatoes.

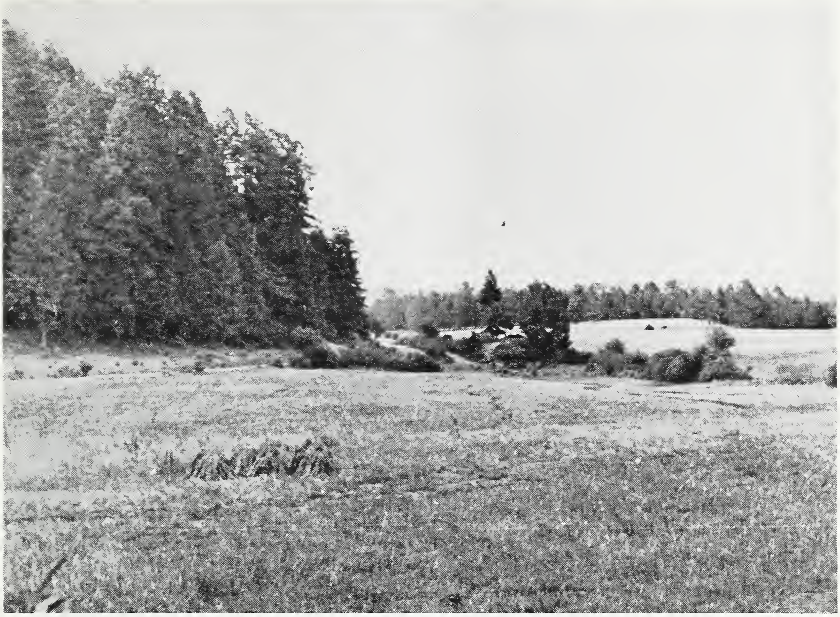

Figure 18.—Balsam forest and cultivated field on Nevada de Toluca, México, a favorite potato habitat.

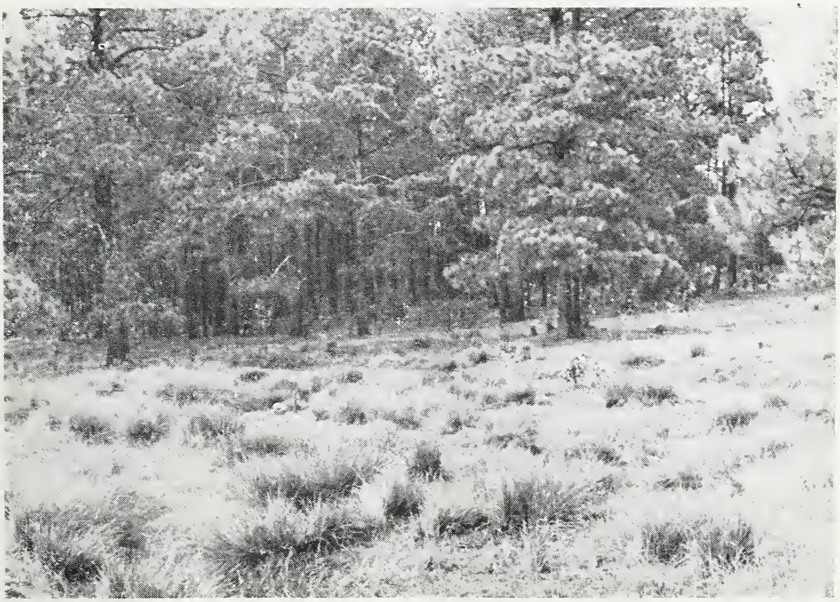

Figure 19.—Pine forest on Nevada de Toluca, México, from the floor of which *Solanum demissum* was taken.

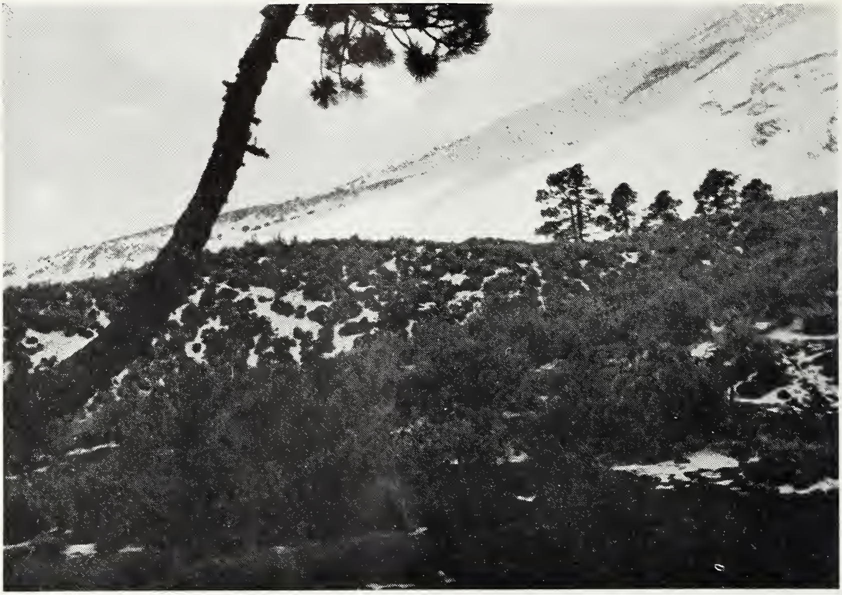

FIGURE 20.—Timber line (about 13,000 feet) near the base of the snow-covered volcanic cone of Popocatepetl, México. This region is above the potato zone.

base of the volcanic cone above snow line (fig. 20). It was found that as one approached timber line the soil was exceedingly hard and full of hoarfrost. Potatoes did not occur there, but were to be found lower in the dense balsam-pine forest zone. Additional exploration should be well worth while on the slopes of these mountains, as well as on the slopes of Ixtaccihuatl (fig. 5).

The chain of mountains extending northward from Popocatepetl, bordering on the States of Puebla (vicinity of Río Frío in particular) and Tlaxcala, were found to have some exceptionally fine colonies of potatoes. The slopes of the mountains bordering the Distrito Federal and Morelos extend well into México (State). This area includes the high mountains about Lake Zempoala (fig. 21), commonly called the alpine region of Mexico, a country noted for its unique fauna and flora. The several large collections here found indicate that further exploration not only in this area but also to the south and northeast of the city of Toluca would be most profitable. Species occurring in México are:

- *S. andigenum*
- *S. appendiculatum*
- *S. bulbocastanum*
- *S. cardiophyllum*
- *S. demissum*
- *S. inscendens*
- *S. longipedicellatum*
- *S. morelliforme*
- *S. polyadenium*
- *S. salamanii*
- *S. semidemissum*
- *S. suaveolens*
- *S. stoloniferum*
- *S. tuberosum*
- *S. verrucosum*

MICHOACÁN: This State probably offers the greatest diversity in tuberous solanums, and on further exploration at all seasons of the year it is possible that it will afford more species than any other, for,

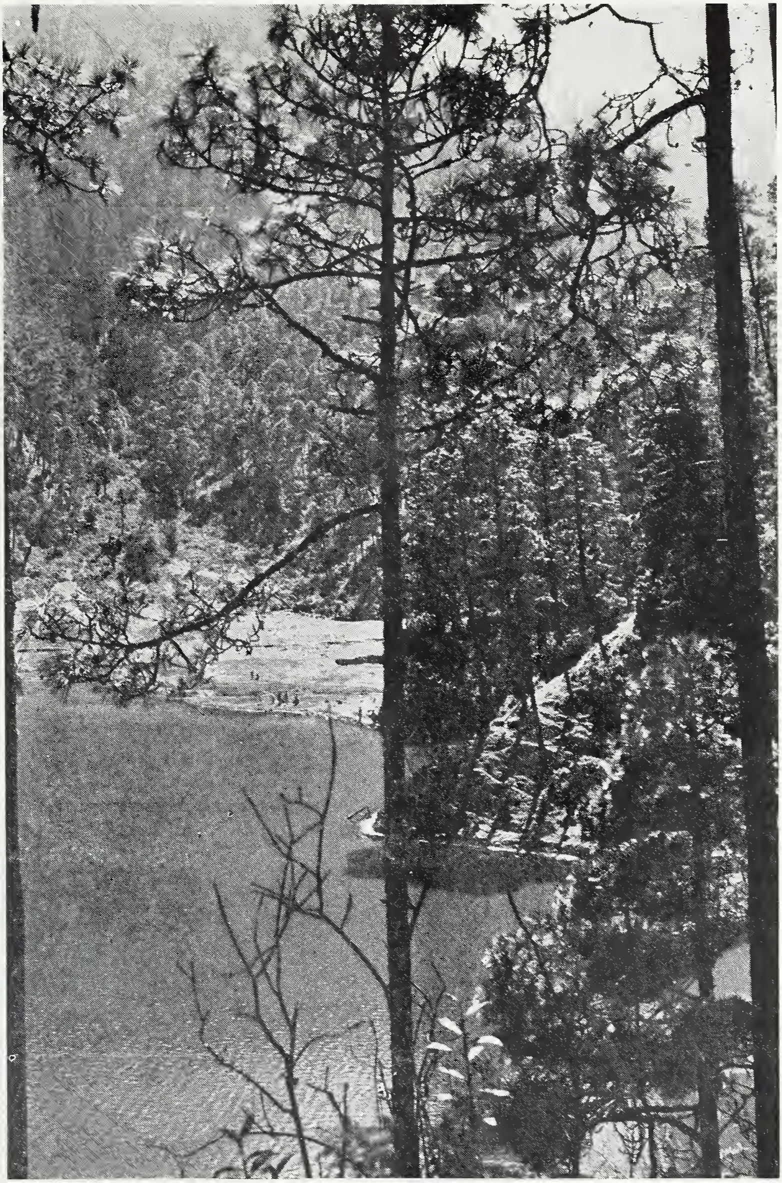

Figure 21.—Lake Zempoala, México. Several collections of potatoes were obtained from the balsam-pine forest on the far slope.

within its boundaries is included the enormous and rugged mountain region known as Mil Cumbres (fig. 22). Besides this extensive territory there are the high mountains in the vicinity of Uruapán (fig. 23) and Patzcuaro (fig. 24), the rather isolated high peaks surrounding Morelia, Pico de Tancitaro, and vicinity, as well as several other somewhat isolated areas. The greater part of the State consists of rugged mountains and high cool valleys, all of which offer great possibilities in the field of wild potatoes. Species occurring in Michoacán are:

S. appendiculatum
S. bulbocastanum
S. demissum
S. galeottii
S. longipedicellatum
S. michoacanum
S. pinnatisectum
S. polyadenium
S. polytrichon
S. stoloniferum
S. tuberosum
S. verrucosum

OAXACA: For the most part Oaxaca is composed of numerous mountains and rather high valleys of a xerophytic nature. Central Oaxaca, in particular, consists of a rugged irregular mass of mountains that attain their highest elevation in Cerro San Felipe, lying just north of the city of Oaxaca, and in Zempoaltepetl. Both of these high mountains are botanically little known. They should be thoroughly explored for potatoes. The writer worked in the pine forests on the middle slopes of Cerro San Felipe, making several collections, among which was *S. bulbocastanum*. This species, however, is more frequently found in less mesophytic environments (fig. 25) than that in which it occurred on Cerro San Felipe. Species occurring in Oaxaca are:

S. appendiculatum
S. bulbocastanum
S. cardiophyllum
S. demissum
S. fendleri
S. stoloniferum
S. verrucosum

PUEBLA: Because of its north-south length, Puebla extends almost the entire width of the most important Mexican potato belt. On its eastern border the State shares with Veracruz the spectacular Pico de Orizaba and much of the high escarpment region. On its western border are found the rugged area about Huauchinango, the slopes of La Malinche (fig. 26), and the chain of mountains including Popocatepetl and Ixtaccihuatl. From these mountainous regions have come numerous collections of potatoes. The high valley in which the city of Puebla lies is also well adapted to potatoes. Species occurring in Puebla are:

S. bulbocastanum
S. cardiophyllum
S. demissum
S. lanciforme
S. morelliforme
S. stoloniferum
S. verrucosum

TLAXCALA: This, the smallest State in Mexico, is strategically located in an area that follows the general pattern of distribution of tuberous solanums. Its southern third contains the long gradual slope and summit of La Malinche, where large colonies of several species occur. Besides this well-known potato region, the writer found that the heavily forested mountains above Tlaxco and on the northwestern

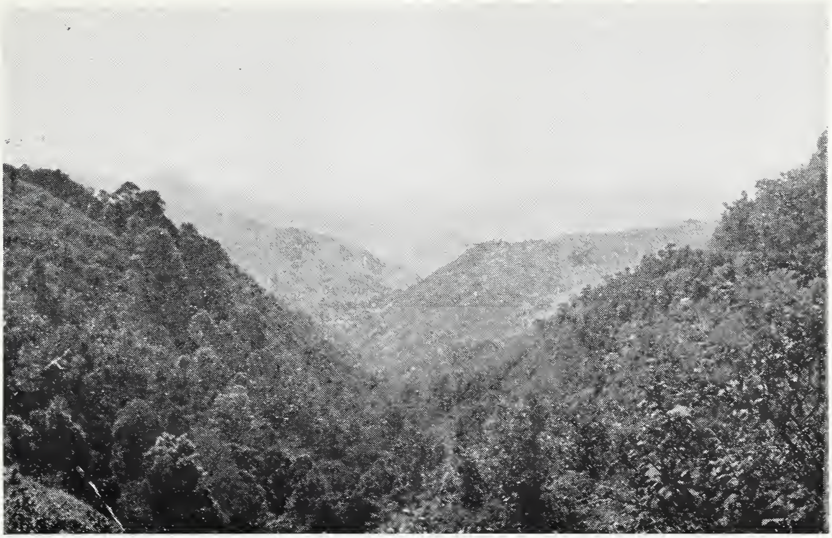

Figure 22.—View of Mil Cumbres (Thousand Peaks), Michoacán, a mountain formation with great possibilities in potato varieties.

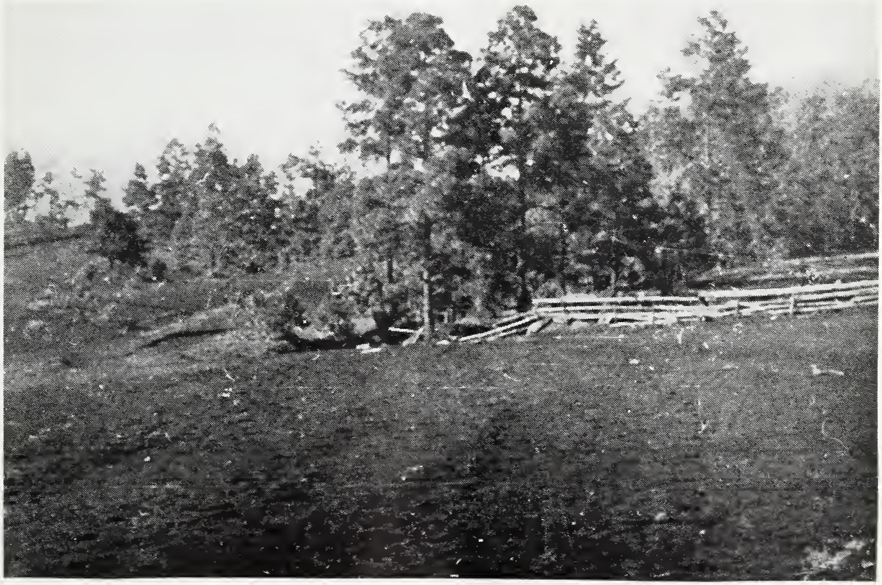

Figure 23.—Fields formerly planted to potatoes now covered with a foot or more of volcanic ash from the active Volcán Parícutin, lying west of Uruapán, Michoacán. Wild potatoes were not found within 10 miles of the volcano.

FIGURE 24.—Lake Patzcuaro, Michoacán, and its surrounding mountains, which support many indigenous potatoes.

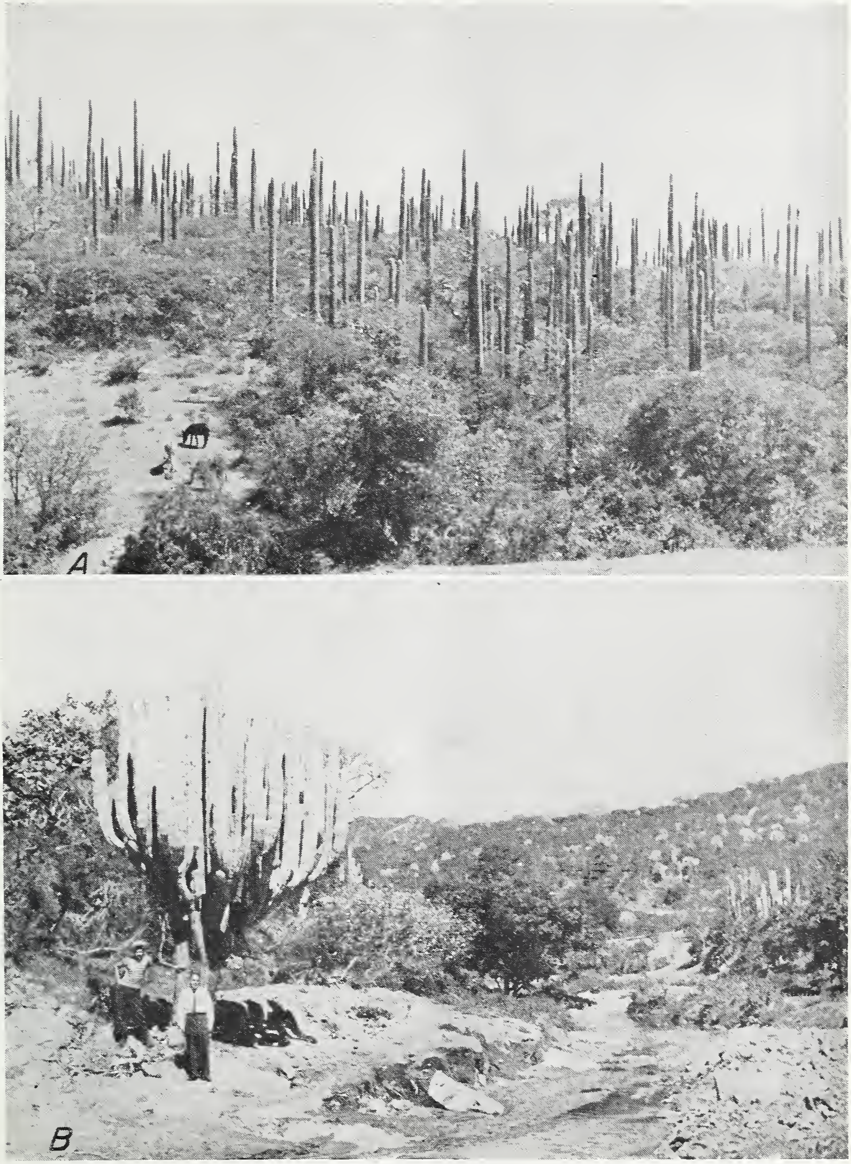

FIGURE 25.—Characteristic habitats of *Solanum bulbocastanum* in Oaxaca: *A*, Only those potato plants that grow among the dense shrubs and columnar cacti escape grazing animals; *B*, *S. bulbocastanum* thrives in dry gravelly talus slopes among shrubs beneath arborescent cacti.

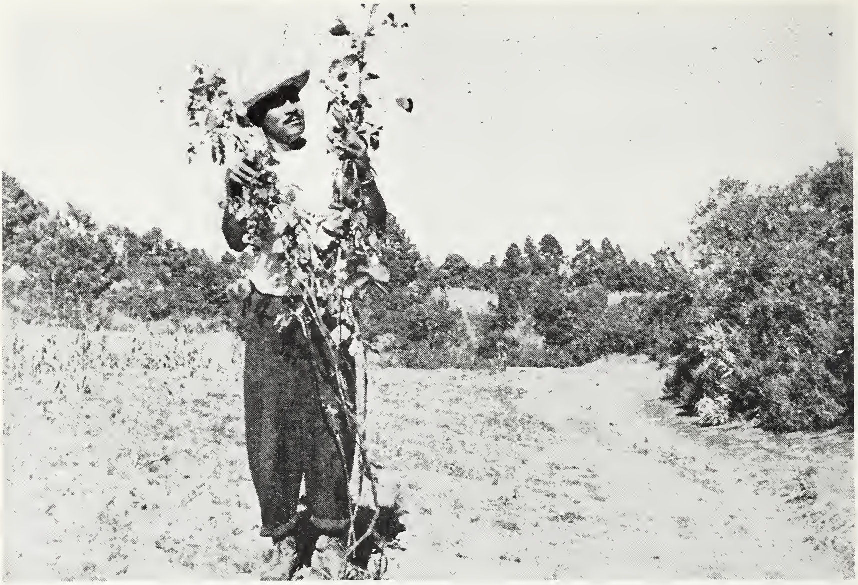

FIGURE 26.—A potato plant more than 7 feet tall, taken from a thicket at the right, on the upper slopes of La Malinche, Puebla. P. I. 161107.

border of the State were also most productive of potatoes. Species occurring in Tlaxcala are:

S. andigenum
S. demissum
S. malinchense
S. tlaxcalense

VERACRUZ: The escarpment region of west-central Veracruz, which also borders Hidalgo and Puebla, is an excellent potato-collecting region, especially late in summer and early in fall. The higher peaks of this country (fig. 27), particularly Pico de Orizaba (the highest point of land in Mexico) and Cofre de Perote, support upon their gradual slopes abundant habitats for wild potatoes. As on all the high mountains, the upper slopes in the pine-balsam forest region are planted to a large acreage of potatoes. This high escarpment region is often covered with fog brought in from the Gulf of Mexico by prevailing winds, a fine condition for the cultivation of potatoes. These mountains, so far as is known, have scarcely been touched by potato collectors, especially Cofre de Perote, where this crop is extensively cultivated. Species occurring in Veracruz are:

S. appendiculatum
S. bulbocastanum
S. demissum
S. ervendbergii
S. inscendens
S. salamanii
S. schenkii
S. suaveolens
S. tuberosum
S. verrucosum

OTHER STATES: The remaining States in which potatoes are found are of less importance to collectors. For the most part also, the indigenous species, especially in the extreme northern part of Mexico, are doubtless of least interest to plant breeders. In fact, one of these,

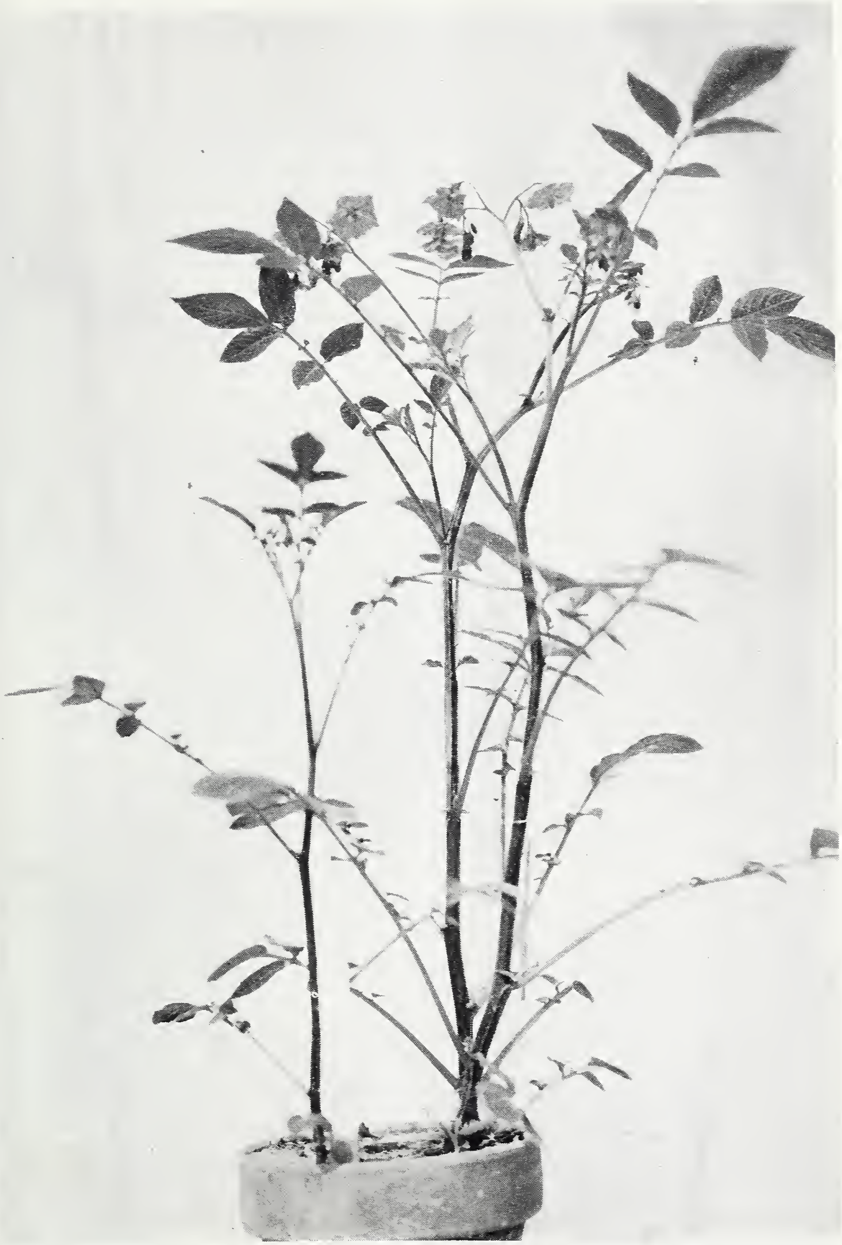

FIGURE 27.—*Solanum verrucosum* plants grown in quarantine from tubers collected in the pine forest on the upper slopes of Cerro Santa Catarina, east of Acultzingo, Veracruz. P. I. 161351. About × ¼.

Solanum jamesii, has been proved of little value for breeding purposes. Isolated areas of importance, however, should be mentioned.

For example, the only known locality for *S. sambucinum*, a most desirable species, is near San Juan del Río, Querétaro. Also, some of the isolated high mountains in Guerrero, although exceedingly dry on their slopes, support extensive mesophytic forests on their summits. One such region (fig. 28) was found to be of much interest with respect to potatoes. Similar areas in this and other States should be explored for possible valuable endemic species. Also, isolated areas often give rise to desirable strains of an otherwise common and widely distributed species. These remaining States and the species that have been found within their boundaries are as follows:

Aguascalientes: *S. cardiophyllum.*
Chiapas: *S. agrimonifolium, S. appendiculatum, S. bulbocastanum, S. morelliforme, S. stoloniferum.*
Chihuahua: *S. brachistotrichum, S. fendleri, S. jamesii, S. tuberosum,*
Coahuila: *S. fendleri, S. tuberosum.*
Colima: *S. verrucosum.*
Durango: *S. fendleri, S. papita, S. subvelutinum, S. tuberosum, S. verrucosum.*
Guanajuato: *S. cardiophyllum, S. longipedicellatum, S. pinnatisectum. S. tuberosum, S. wightianum.*
Guerrero: *S. bulbocastanum, S. longipedicellatum, S. stoloniferum.*
Morelos: *S. bulbocastanum, S. longipedicellatum, S. tuberosum.*
Nayarit: *S. nayaritense.*
Nuevo León: *S. fendleri, S. tuberosum.*
Querétaro: *S. cardiophyllum, S. pinnatisectum, S. sambucinum, S. stoloniferum, S. tuberosum.*
San Luis Potosí: *S. cardiophyllum, S. demissum, S. ehrenbergii, S. polytrichon, S. tuberosum, S. verrucosum.*
Sinaloa: *S. appendiculatum, S. cardiophyllum.*
Sonora: *S. fendleri, S. jamesii, S. tuberosum.*
Tamaulipas: *S. fendleri.*
Yucatán: *S. tuberosum.*
Zacatecas: *S. cardiophyllum, S. demissum.*

SECTION TUBERARIUM OF THE GENUS *SOLANUM*

Below are listed the recognized species (exclusive of varieties and forms) in the section Tuberarium of the genus *Solanum* and the Mexican States in which each is found. These data are based on herbarium specimens and reports of reputable workers. When critical study of the following species is undertaken, in conjunction with the identification and classification of the writer's collections, there may be some necessary revisions in the nomenclature of the Mexican potatoes. Nevertheless, for the time being, a rather representative picture of the distribution by States of the tuberous solanums may be gained from the following data.

As would be expected, *S. tuberosum* is the most widespread of the species. Since this is perhaps the one most commonly cultivated, many of the specimens doubtless represent individuals that have escaped from cultivation rather than wild strains. Two of the most desirable species, *S. polyadenium* and *S. sambucinum*, are of very limited distribution. A third desirable species, however, *S. demissum*, has a surprisingly wide distribution. The following list should be of

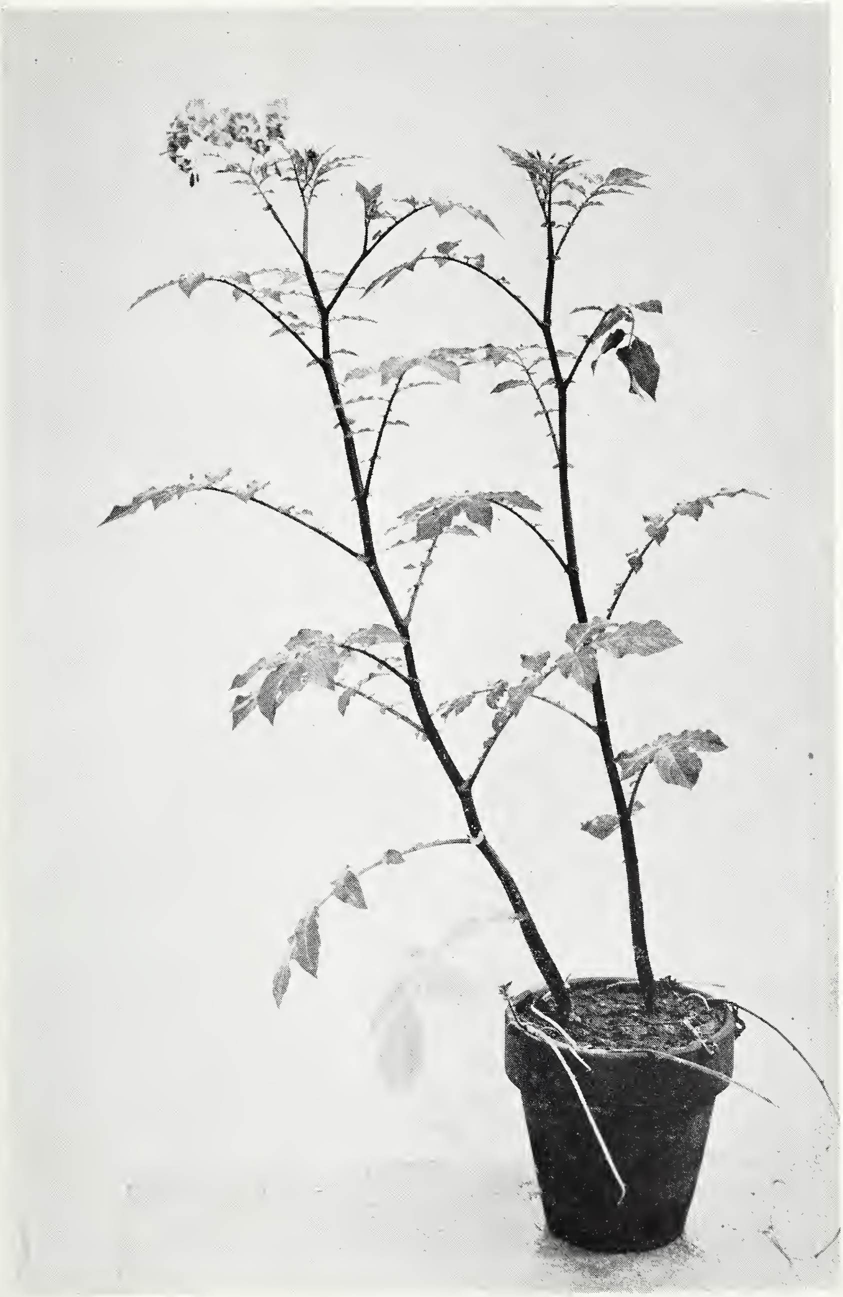

FIGURE 28.—*Solanum longipedicellatum* plants grown in quarantine from tubers collected near Los Tojocodes, summit of mountains above Mazatlán, Guerrero. P. I. 161745. About × ¼.

use in making immediately available information concerning the general distribution of a species in Mexico.

S. agrimonifolium Rydb.: Chiapas.
S. ajuscoënse Buk.: Distrito Federal.
S. andigenum Juz. and Buk. (and variants): Distrito Federal, México, Tlaxcala.
S. antipoviczii Buk.: Distrito Federal.
S. appendiculatum Humb. and Bonpl.: Chiapas, Hidalgo, México, Michoacán, Oaxaca, Sinaloa, Veracruz.
S. brachistotrichum (Bitt.) Rydb.: Chihuahua.
S. bulbocastanum Dun. (and variants): Chiapas, Distrito Federal, Guerrero, Jalisco, México, Michoacán, Morelos, Oaxaca, Puebla, Veracruz.
S. cardiophyllum Bitt. (and variants): Aguascalientes, Distrito Federal, Guanajuato, Hidalgo, Jalisco, México, Oaxaca, Puebla, Querétaro, San Luis Potosí, Sinaloa, Zacatecas.
S. demissum Lindl. (fig. 29) (and variants): Distrito Federal, Hidalgo, México, Michoacán, Oaxaca, Puebla, San Luis Potosí, Tlaxcala, Veracruz, Zacatecas.
S. ehrenbergii (Bitt.) Rydb.: San Luis Potosí.
S. ervendbergii Rydb.: Veracruz.
S. fendleri A. Gray: Chihuahua, Coahuila, Durango, Hidalgo, Nuevo León, Oaxaca, Sonora, Tamaulipas.
S. galeottii Dun.: Michoacán.
S. inscendens Rydb.: Hidalgo, México, Veracruz.
S. jamesii Torr. (and variants): Chihuahua, Sonora.
S. lanciforme (Bitt.) Rydb.: Hidalgo, Puebla.
S. longipedicellatum Bitt. (figs. 30, 31, and 32): Distrito Federal, Guanajuato, Guerrero, Michoacán, Morelos.
S. malinchense Hawkes: Tlaxcala.
S. michoacanum (Bitt.) Rydb.: Michoacán.
S. morelliforme Bitt. and Muench.: Chiapas, México, Puebla.
S. nayaritense (Bitt.) Rydb.: Nayarit.
S. oxycarpum Schiede: Malpays de la Joya (State uncertain).
S. papita Rydb.: Durango.
S. pinnatisectum Dun.: Guanajuato, Michoacán, Querétaro.
S. polyadenium Greenm.: Hidalgo, México, Michoacán.
S. polytrichon Rydb.: Michoacán, San Luis Potosí.
S. salamanii Hawkes: México, Veracruz.
S. sambucinum Rydb.: Querétaro.
S. schenkii Bitt.: Veracruz.
S. schizostigma Bitt.: No definite locality known.
S. semidemissum Juz.: Distrito Federal, México.
S. stenophyllidium Bitt.: Jalisco.
S. stoloniferum Schlecht. and Bouché: Chiapas, Distrito Federal, Guerrero, México, Michoacán, Oaxaca, Puebla, Querétaro.
S suaveolens Kunth and Bouché: Distrito Federal, México, Veracruz.
S. subvelutinum Rydb.: Durango, Jalisco.
S. tlaxcalense Hawkes: Tlaxcala.
S. tuberosum L. (and variants): Chihuahua, Coahuila, Distrito Federal, Durango, Guanajuato, México, Michoacán, Morelos, Nuevo León, Querétaro, San Luis Potosí, Sonora, Veracruz, Yucatán.
S. vallis-mexici Juz.: Distrito Federal.
S. verrucosum Schlecht.: Colima, Distrito Federal, Durango, Hidalgo, Jalisco, México, Michoacán, Oaxaca, Puebla, San Luis Potosí, Veracruz.
S. wightianum Rydb.: Guanajuato.

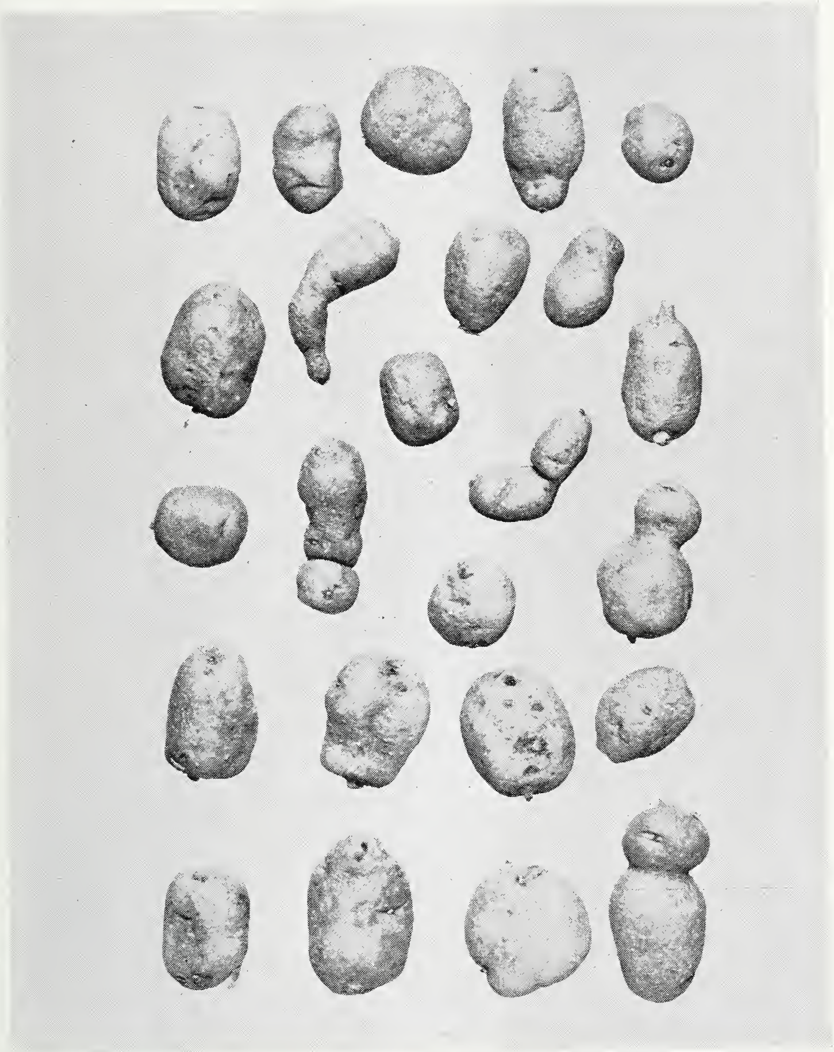

FIGURE 29.—Tubers of *Solanum demissum*, about the average size found in nature, collected in thicket of open pine forest at Selva Obscura, Puebla. P. I. 161682 and P. I. 161769. About × 1.

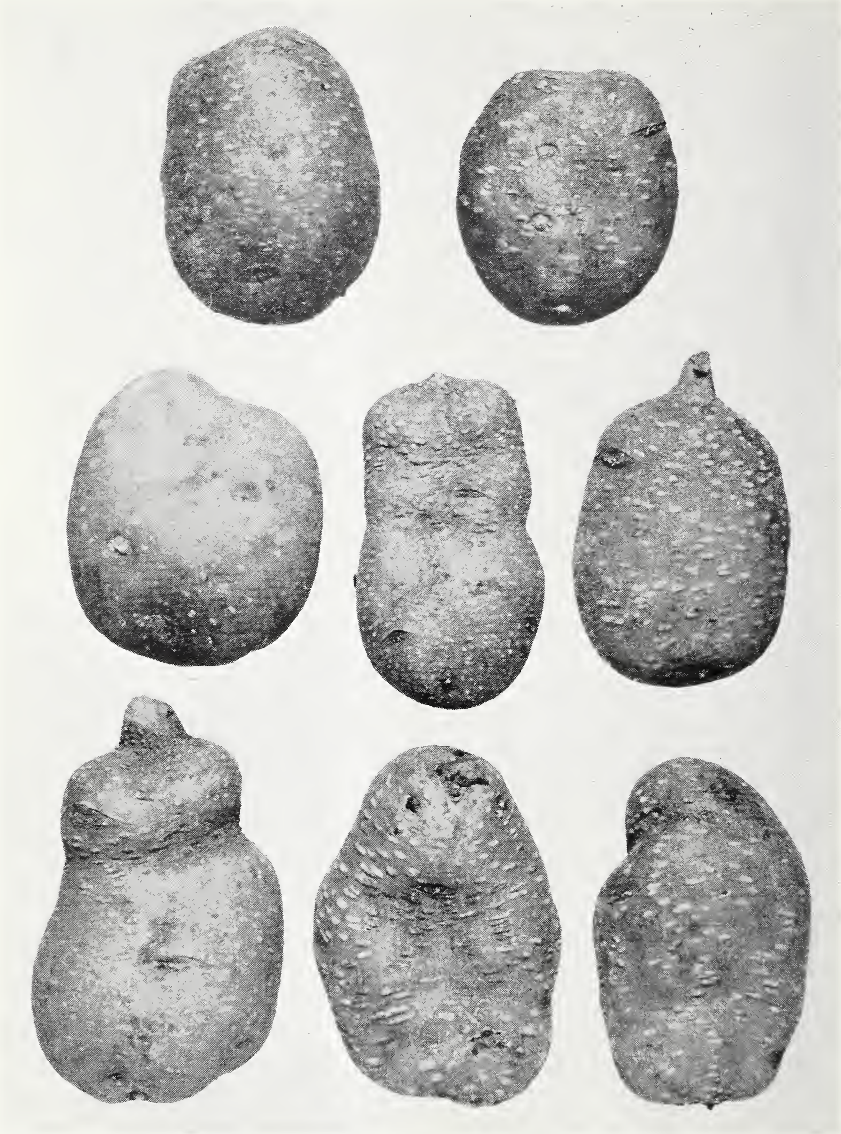

FIGURE 30.—Characteristic tubers of *Solanum longipedicellatum*, collected on mountains in the vicinity of Pino Gordo, Michoacán. P. I. 161715. About × 1.

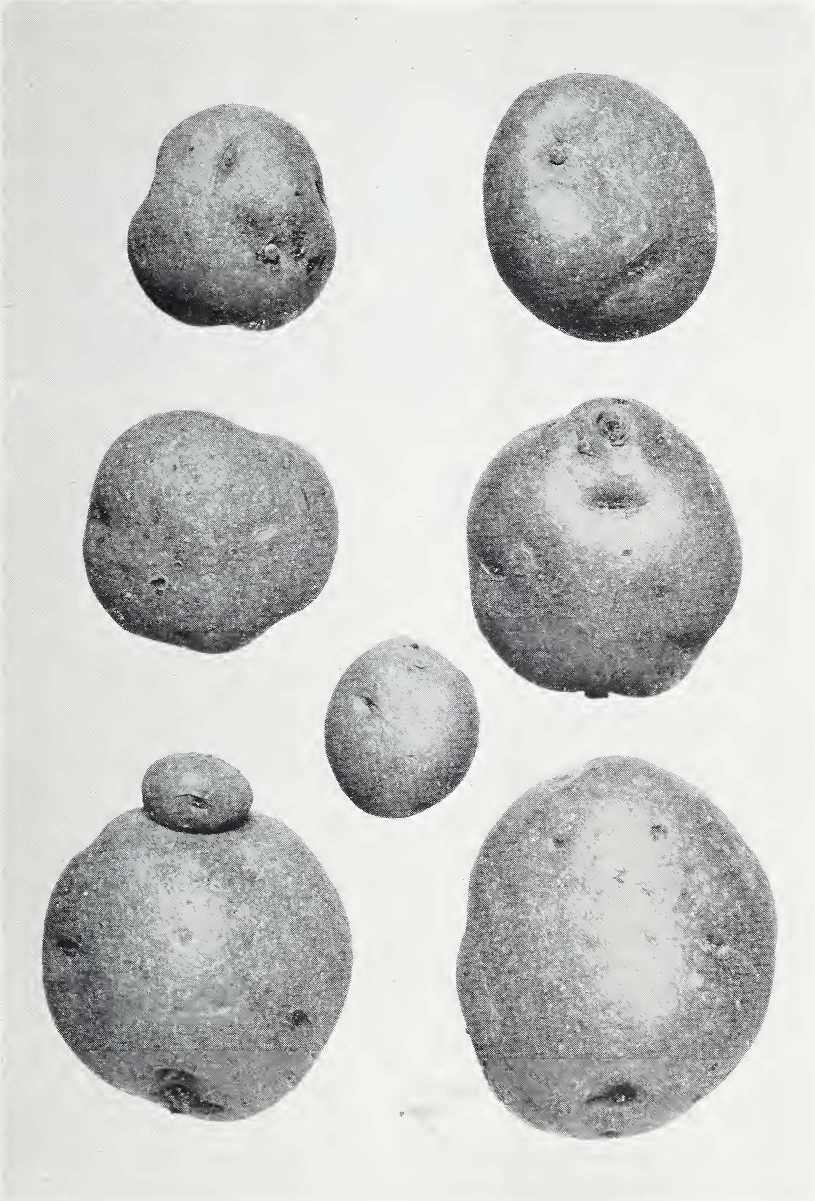

FIGURE 31.—Another type of tuber of *Solanum longipedicellatum*, collected on the edge of cornfields on mountain slopes above Tres Cumbres, Morelos. P. I. 161718 and P. I. 161731. About × 1.

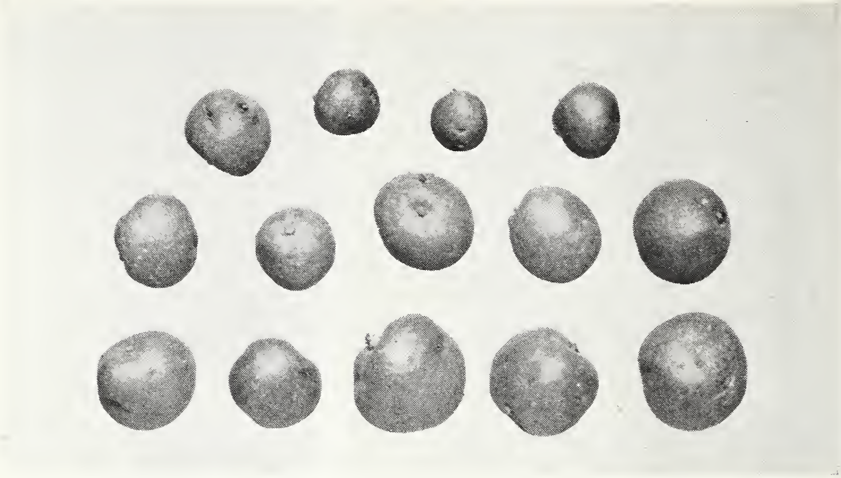

FIGURE 32.—A third type of tuber of *Solanum longipedicellatum*, collected among maguey plants near Macho de Agua, Michoacán. P. I. 161703. About × 1.

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